The Measurement of Scientific and Technological Activities

Oslo Manual

GUIDELINES FOR COLLECTING AND INTERPRETING INNOVATION DATA

Third edition

A joint publication of OECD and Eurostat

ORGANISATION FOR ECONOMIC CO-OPERATION AND DEVELOPMENT
STATISTICAL OFFICE OF THE EUROPEAN COMMUNITIES

ORGANISATION FOR ECONOMIC CO-OPERATION AND DEVELOPMENT

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Foreword

It has been long understood that the generation, exploitation and diffusion of knowledge are fundamental to economic growth, development and the well being of nations. Central to this is the need for better measures of innovation. Over time the nature and landscape of innovation have changed, and so has the need for indicators to capture those changes and provide policy makers with appropriate tools of analysis. A considerable body of work was undertaken during the 1980s and 1990s to develop models and analytical frameworks for the study of innovation. Experimentation with early surveys and their results, along with the need for a coherent set of concepts and tools led to the first edition of the Oslo Manual in 1992, which focused on technological product and process (TPP) innovation in manufacturing. This became the reference for various large scale surveys examining the nature and impacts of innovation in the business sector, such as the European Community Innovation Survey (CIS), currently in its fourth round. Results from such surveys have driven further refinements in the Oslo Manual framework in terms of concepts, definitions and methodology leading to a second edition published in 1997 which, among other things, expanded coverage to service sectors.

Since then, the analysis of results from surveys and changing policy needs led to the launching of another revision of the manual, the result of which can be found in this third edition. As there has been a growing sense that much of innovation in service sectors is not adequately captured by the TPP concept, it was decided to address the question of non technological innovation in this revision. As a result, the scope of what is considered an innovation has now been expanded to include two new types: marketing and organisational innovation. These are certainly new concepts, but they have already been tested in several OECD countries, with promising results.

New to this edition is also an effort to address the systemic dimension of innovation, through a chapter focusing on innovation linkages. Lessons drawn from results of previous surveys have also been incorporated in order to refine existing concepts and methodological issues, such as the measurement of innovation inputs and outcomes, as well as the improvement of data collection methods.

Innovation also occurs outside the OECD region: a growing number of countries in Latin America, Eastern Europe, Asia and Africa have begun undertaking surveys based on the Oslo Manual. Although the design of those surveys was usually intended to comply with such standards, many of them have adapted the Oslo methodology to take into account specific user needs and the characteristics of statistical systems in these countries with different economic and social backgrounds. National adaptations

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were developed by each country and followed different approaches. For example, it is widely accepted that diffusion and incremental changes to innovation account for much of the innovation occurring in non OECD countries. Using these rich and diverse experiences, an annex has been added to this edition of the Oslo Manual that draws on some of the lessons learned, and provides further guidance for future innovation surveys in non OECD countries.

The Oslo Manual, developed jointly by Eurostat and the OECD, is part of a continuously evolving family of manuals devoted to the measurement and interpretation of data relating to science, technology and innovation. This includes manuals, guidelines and handbooks covering R&D (Frascati Manual), globalisation indicators, patents, the information society, human resources in S&T (Canberra Manual), and biotechnology statistics.

Prepared under the joint aegis of the OECD and the European Commission (Eurostat), this third edition of the Oslo Manual is the result of a three year collaborative process that has involved the OECD Working Party of National Experts on Science and Technology Indicators (NESTI) and the Eurostat Working Party on Science, Technology and Innovation Statistics (WPSTI) as well as a number of outside experts. This manual provides guidelines for collecting and interpreting innovation data in an internationally comparable manner. Finding consensus has sometimes meant reaching compromises and agreeing to conventions. As with other such guidelines, there are known limitations, but each edition of the Oslo Manual constitutes a step forward in our understanding of the innovation process. While this ongoing, incremental learning incorporates the lessons of earlier studies, the Manual is also an ambitious tool in which experimentation and testing are used to challenge the boundaries of what is understood by innovation.

Many should be thanked for their valuable contributions. A special acknowledgement goes to experts from Canada, France, Germany, Italy, Japan, the Netherlands, Norway and the United Kingdom who led the work of six focus groups which examined a variety of topics and expressed valuable recommendations for the revision. The drafting of the revised Oslo Manual was undertaken by Dr. Peter Mortensen and Dr. Carter Bloch from the Danish Centre for Studies in Research and Research Policy, under the guidance of the OECD and Eurostat. The annex on innovation surveys in developing countries was drafted by the UNESCO Institute for Statistics, based on a proposal and draft paper by the Red Iberoamericana de Indicadores de Ciencia y Tecnología *(RICYT) and following a broad process of consultation with many national experts.*

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Chapter 1

Objectives and Scope of the Manual

1. Introduction

1. It is widely accepted that innovation is central to the growth of output and productivity. However, while our understanding of innovation activities and their economic impact has greatly increased since the first edition of the Manual, it is still deficient. For example, as the world economy evolves, so does the process of innovation. Globalisation has led to dramatic increases in access to information and new markets for firms. It has also resulted in greater international competition and in new organisational forms in order to manage global supply chains. Owing to advances in technologies and greater flows of information, knowledge is more and more viewed as a central driver of economic growth and innovation. Yet, we do not fully understand how these factors affect innovation.

2. In order to develop policies that support innovation appropriately, it is necessary to better understand several critical aspects of the innovation process, such as innovation activities other than R&D, the interactions among actors and the relevant knowledge flows. Policy development also requires further advances in the analysis of innovation, which in turn requires obtaining better information.

3. The first edition of the Manual, issued in 1992, and the surveys undertaken using it, including the Community Innovation Survey (CIS) organised by the EU and comparable surveys in Australia and Canada, showed that it is possible to develop and collect data on the complex and differentiated process of innovation.

4. The second edition, issued in 1997, updated the framework of concepts, definitions and methodology to incorporate survey experience and greater understanding of the innovation process and to cover a wider range of industries. It improved the guidelines for developing internationally comparable innovation indicators for OECD countries and discussed the analytical and policy problems for which the indicators have relevance.

5. Both the first and second editions used the technological product and process (TPP) definition of innovation. This reflected a focus on firms' technological development of new products and new production techniques and their diffusion to other firms. Discussion of organisational innovation and non-technological innovation was included in an annex.

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6. Since 1992, the number of countries conducting innovation surveys has grown dramatically: EU countries, other OECD countries such as Canada, Australia, New Zealand and Japan, and a large number of non-OECD economies, among them several Latin American countries, Russia and South Africa.

7. This third edition of the Manual draws on the large amount of data and experience resulting from these surveys. It expands the innovation measurement framework in three important ways. First, it places greater emphasis on the role of linkages with other firms and institutions in the innovation process. Second, it recognises the importance of innovation in less R&D-intensive industries, such as services and low-technology manufacturing. This edition modifies certain aspects of the framework (such as definitions and relevant activities) to better accommodate the services sector. Third, the definition of innovation is expanded to include two additional types of innovations, organisational innovation and marketing innovation. Also new to the Manual is an annex on innovation surveys in non-OECD countries and reflects the fact that a growing number of them now conduct innovation surveys.

8. Evaluation of linkages is expanded because of the importance of knowledge flows among firms and other organisations for the development and diffusion of innovations. This helps to highlight the role of organisational structures and practices that promote the sharing and use of knowledge and interaction with other firms and public research institutions. These also include the forming of closer relationships with suppliers and ongoing development of marketing practices to better reach customers. Linkages are now addressed in a separate chapter covering a variety of interactions ranging from arm's-length exchanges of information to active involvement in joint innovation projects.

9. While the second edition of the Manual covered services, it primarily focused on manufacturing industries. However, innovation in services-oriented sectors can differ substantially from innovation in many manufacturing-oriented sectors. It is often less formally organised, more incremental in nature and less technological. In order to establish a framework that better accommodates this broad range of industries, this edition modifies a number of definitions, terms and concepts.

10. To identify the full range of changes that firms make to improve performance and their success in improving economic outcomes requires a broader framework than technological product and process innovation. The inclusion of marketing and organisational innovations creates a more complete framework, one that is better able to capture the changes that affect firm performance and contribute to the accumulation of knowledge.

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11. The role of organisational innovation is emphasised by Lam (2005): "Economists assume that organisational change is a response to technical change, when in fact organisational innovation could be a necessary precondition for technical innovation." Organisational innovations are not only a supporting factor for product and process innovations; they can also have an important impact on firm performance on their own. Organisational innovations can improve the quality and efficiency of work, enhance the exchange of information, and improve firms' ability to learn and utilise new knowledge and technologies.

12. Firms may also allocate large amounts of resources to market research and the development of new marketing practices, such as targeting new markets or market segments and developing new ways of promoting products. New marketing practices can play a central role in firms' performance. Marketing practices are also important for the success of new products, and market research and contacts with customers can play a crucial role in product and process development through demand-led innovation. The inclusion of organisational and marketing innovation also allows for more extensive analysis of the interactions between different types of innovations, in particular the importance of implementing organisational changes in order to benefit from other types of innovations.

13. Organisational innovations were discussed in the second edition of the Manual, and there is now some practical experience with collection of data on organisational changes. This experience includes specialised surveys on organisational innovation (Wengel *et al.*, 2000)and its inclusion in innovation surveys (*e.g.* Australian Innovation Survey 2003) or questions on organisational changes (the CIS3 survey, the Japanese National Innovation Survey 2003, among others). This type of data has also been used in empirical analysis, for example of the relationship between organisational innovation, ICT investment and productivity (*e.g.* Brynjolfsson and Hitt, 2000; OECD, 2004).

14. Marketing innovations are new to the Manual. While there is less experience with marketing innovations than with organisational innovations, questions on marketing changes have been included in a number of innovation surveys,[1] and there has been substantial field testing of marketing concepts in a number of countries.

15. To achieve a full picture of innovation activities, it is necessary to include marketing methods in the framework. There are at least two reasons for including these as a separate category, as opposed to integrating them with organisational or process innovations. First, marketing innovations can be important for firm performance and the overall innovation process. Identifying marketing innovations allows for the analysis of their impact and

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their interaction with other types of innovations. Second, a defining characteristic of marketing innovations is the orientation towards customers and markets, with a view to improving sales and market share. These economic objectives may differ greatly from those of process innovations, which tend to focus on productive quality and efficiency. Grouping marketing innovations with organisational innovations would also be problematic because some marketing practices do not fit into concepts of organisational changes and because this would greatly dilute data on organisational innovations, making it difficult to interpret the results.

16. The Manual's definitions and concepts have therefore been adapted, based on survey experience in Australia and other countries, to include organisational and marketing innovations in innovation surveys. The definitions of these types of innovations are still under development and are less well established than the definitions of product and process innovation.

17. The goals and scope of innovation surveys can differ in terms of the aspects of innovation to be covered and the level of detail. Furthermore, in expanding coverage from product and process innovation to include marketing and organisational innovation, surveys can take one of a number of approaches. For example, they can provide equal coverage of all types of innovation and cover marketing and organisational innovation to some extent, while still maintaining product and process innovations as the core innovation types, or they can focus exclusively on product and process innovation. The Manual provides guidelines that can be of use for all types of approaches. In addition, one or more types of innovations can be covered in greater detail through specialised surveys.

18. The addition of organisational and marketing innovations, along with the use of a broad definition of innovation that includes activities to both develop and adopt innovations, means that an increasing percentage of firms is likely to meet the basic requirements for being "innovative". Methods are therefore needed for identifying different types of innovative firms, based on the types of innovations that they have implemented and on their innovative capabilities and activities. It is not enough to know whether firms are innovative or not; it is necessary to know how firms innovate and what types of innovations they implement.

19. With these points in mind, the aim of the present chapter is to give an overview of the coverage and contents of the Manual (see Box 1.1).

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Box 1.1. **Structure of the Manual**

The Manual starts with a general discussion of points that are likely to have some effect on the choice of indicators (Chapter 2):

- An adequate conceptual understanding of the structure and characteristics of the innovation process and its implications for policymaking.
- The key unresolved problems which further data could clarify.

It continues with a framework for innovation surveys:

- Basic definitions of innovation, innovation activities and the innovative firm (Chapter 3).
- Institutional classifications (Chapter 4).

After that, suggestions and recommendations are made as to the types of issues to be covered in national and international innovation surveys:

- Measuring linkages in the innovation process; types of knowledge and their sources (Chapter 5).
- Innovation activities and their measurement (Chapter 6).
- Objectives, barriers and impacts of innovation (Chapter 7).

The Manual also contains two annexes:

- Innovation surveys in developing economies (Annex A).
- A detailed list of innovation examples (Annex B).

2. Factors influencing the scope of the Manual

20. The aim of the Manual is to provide guidelines for the collection and interpretation of data on innovation. Innovation data can have many uses and the Manual is designed to accommodate these various uses. One reason for collecting innovation data is to better understand innovation and its relation to economic growth. This requires both knowledge of innovation activities that have a direct impact on firm performance (for example through greater demand or reduced costs), and of the factors that affect their ability to innovate. Another purpose is to provide indicators for benchmarking national performance. This both informs policy making and allows for international comparison. There is a need to collect new indicators but also a desire to maintain existing indicators for comparisons over time. The Manual is designed to achieve a balance between these different needs.

21. How can one decide on the appropriate scope, structure, terminology, etc., for internationally comparable data collection? The variety of subjects covered by both specialised and general innovation surveys is evidence that

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many types of data are potentially available. Obviously, a survey covering all possible topics would be excessively cumbersome. Priorities must be identified, and topics, industries and survey approaches on which to concentrate must be chosen. There are two main issues: what is measurable and what is it of value to measure?

2.1. What is measurable?

22. Innovation is a continuous process. Firms constantly make changes to products and processes and collect new knowledge, and it is more difficult to measure a dynamic process than a static activity. With the objective of capturing this process, the Manual presents guidelines for collecting data on the general process of innovation (for example, innovation activities, expenditures and linkages), the implementation of significant changes in the firm (*i.e.* innovations), the factors that influence innovation activities, and the outcomes of innovation.

2.2. What is it of value to measure?

23. In constructing innovation indicators, the information needs of policy makers and analysts are a paramount consideration. Chapter 2 reviews these needs, which are part of the broad information system that helps to reduce uncertainty in policy making and which have been influenced, since the first edition of the Manual, by developments in the economics of innovation.

24. Innovation policy has developed as an amalgam of science and technology policy and industrial policy. It takes as a given that knowledge in all its forms plays a crucial role in economic progress, and that innovation is a complex and systemic phenomenon. Systems approaches to innovation shift the focus of policy towards an emphasis on the interplay of institutions and the interactive processes at work in the creation of knowledge and in its diffusion and application. The term "national innovation system" has been coined to represent this set of institutions and these knowledge flows. This theoretical perspective influences the choice of questions to include in an innovation survey, and the need, for example, of extensive coverage of linkages and knowledge sources.

25. Systems approaches complement theories that focus on the innovative firm, the reasons for innovating and the activities undertaken by firms. The forces that drive innovation at the level of the firm and the innovations that succeed in improving firm performance are of central importance for policy making. Questions on the implementation of innovations, the interaction of different types of innovations, and on the objectives and barriers to innovation are the source of relevant data.

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3. Scope of the Manual

26. For reasons summarised below:

- The Manual covers innovation in the business enterprise sector only.
- It deals with innovation at the level of the firm.
- It covers four types of innovations: product, process, organisational and marketing.
- It covers diffusion up to "new to the firm".

3.1. Sector coverage

27. Innovation can occur in any sector of the economy, including government services such as health or education. The Manual's guidelines, however, are essentially designed to deal with innovations in the business enterprise sector alone. This includes manufacturing, primary industries and the services sector.

28. Innovation is also important for the public sector. However, less is known about innovation processes in non-market-oriented sectors. Much work remains to be done to study innovation and develop a framework for the collection of innovation data in the public sector.[2] Such work could form the basis for a separate manual.

3.2. Innovation at the level of the firm

29. The Manual is concerned with the collection of innovation data at the level of the firm. It does not cover industry- or economy-wide changes such as the emergence of a new market, the development of a new source of raw materials or semi-manufactured goods, or the reorganisation of an industry. Nonetheless, it is possible in some cases to estimate industry- or economy-wide changes, such as the emergence of a new market or industry reorganisation, by aggregating data for individual firms.

30. The first three chapters of the Manual use the generic term "firm". The term is given a specific statistical definition in Chapter 4, which deals with classifications. The precise definition used in a study or survey can affect the results, as the subsidiaries of multinational corporations may be organised in different ways, or a multinational may introduce a given innovation country by country, market by market, or simultaneously throughout the group.

3.3. Types of innovations

31. A firm can make many types of changes in its methods of work, its use of factors of production and the types of output that improve its productivity and/or commercial performance. The Manual defines four types of innovations that encompass a wide range of changes in firms' activities:

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product innovations, process innovations, organisational innovations and marketing innovations.

32. Full definitions of the four types of innovations can be found in Chapter 3. Product innovations involve significant changes in the capabilities of goods or services. Both entirely new goods and services and significant improvements to existing products are included. Process innovations represent significant changes in production and delivery methods.

33. Organisational innovations refer to the implementation of new organisational methods. These can be changes in business practices, in workplace organisation or in the firm's external relations. Marketing innovations involve the implementation of new marketing methods. These can include changes in product design and packaging, in product promotion and placement, and in methods for pricing goods and services.

34. An important concern when expanding the definition of innovation is to maintain continuity with the earlier definition of technological product and process (TPP) innovation.[3] However, the decision to include the services sector requires a few minor modifications in the definitions of product and process innovation to reflect innovation activities in the services sector more adequately and to reduce the manufacturing orientation. The revised definitions (see Chapter 3) remain very comparable to the earlier (TPP) ones.

35. One change is the removal of the word "technological" from the definitions, as the word raises a concern that many services sector firms would interpret "technological" to mean "using high-technology plant and equipment", and thus not applicable to many of their product and process innovations.

3.4. Diffusion and the degree of novelty

36. The Manual deals with changes that involve a significant degree of *novelty* for the firm. It excludes changes that are minor or lack a sufficient degree of novelty. However, an innovation does not need to be developed by the firm itself but can be acquired from other firms or institutions through the process of diffusion.

37. Diffusion is the way in which innovations spread, through market or non-market channels, from their very first implementation to different consumers, countries, regions, sectors, markets and firms. Without diffusion, an innovation has no economic impact. The minimum requirement for a change in a firm's products or functions to be considered an innovation is that it is new (or significantly improved) to the firm. Three other concepts for the novelty of innovations are discussed in Chapter 3: new to the market, new to the world and disruptive innovations.

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38. There are two main reasons for using "new to the firm" as the minimum requirement of an innovation. First, adoption of innovations is important for the innovation system as a whole. It involves a flow of knowledge to adopting firms. Furthermore, the learning process in adopting an innovation can lead to subsequent improvements in the innovation and to the development of new products, processes and other innovations. Second, the main impact of innovation on economic activity stems from the diffusion of initial innovations to other firms. Diffusion is captured by covering innovations that are new to the firm.

39. Of note, the Manual does not cover the diffusion of a new technology to other divisions or parts of a firm after its initial adoption or commercialisation.[4] For example, the first implementation of new production technology in one of five factories owned by the same firm is counted as innovation, but implementation of the same technology in the remaining four factories is not.

4. Providing data on the key issues

4.1. *Innovation activities and expenditures*

40. Innovation activities include all scientific, technological, organisational, financial and commercial steps which actually lead, or are intended to lead, to the implementation of innovations. Some of these activities may be innovative in their own right, while others are not novel but are necessary to implementation.

41. Innovation comprises a number of activities that are not included in R&D, such as later phases of development for preproduction, production and distribution, development activities with a lesser degree of novelty, support activities such as training and market preparation, and development and implementation activities for innovations such as new marketing methods or new organisational methods which are not product and process innovations. Innovation activities may also include acquisition of external knowledge or capital goods that is not part of R&D. A detailed breakdown of innovation activities and their descriptions, along with measurement issues, can be found in Chapter 6.

42. During a given period, a firm's innovation activities may be of three kinds:

- *Successful* in having resulted in the implementation of a new innovation (though not necessarily commercially successful).
- *Ongoing*, work in progress, which has not yet resulted in the implementation of an innovation.
- *Abandoned* before the implementation of an innovation.

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43. Expenditures are measured on the basis of the sum of these three kinds of activity over a given period of time (see Chapter 6). An alternative would be to collect information on total expenditures on activities related to individual innovations. Firms have found it difficult to report a full set of data whichever approach is used, yet this is an essential data set for economic and policy analysis purposes. It is hoped that, with successive exercises, firms will find it in their own interest to cost their innovation activities.

4.2. Factors influencing innovation

44. Enterprises can engage in innovation for a number of reasons. Their objectives may involve products, markets, efficiency, quality or the ability to learn and to implement changes. Identifying enterprises' motives for innovating and their importance is of help in examining the forces that drive innovation activities, such as competition and opportunities for entering new markets.

45. Innovation activities can be hampered by a number of factors. There may be reasons for not starting innovation activities at all, or there may be factors that slow such activities or affect them negatively. These include economic factors, such as high costs or lack of demand, factors specific to an enterprise, such as lack of skilled personnel or knowledge, and legal factors, such as regulations or tax rules.

46. The ability of enterprises to appropriate the gains from their innovation activities also affects innovation. If, for example, enterprises are unable to protect their innovations from imitation by competitors, they will have less incentive to innovate. On the other hand, if an industry functions well without formal protection, promoting such protection can slow the flow of knowledge and technology and lead to higher prices for goods and services.

4.3. The innovating firm and the impact of innovation

47. The innovative firm (defined in Chapter 3) is one that has introduced an innovation during the period under review. Such innovations need not have been a commercial success: many innovations fail. Innovative firms can be divided into those that have mainly developed innovations on their own or in co-operation with other firms or public research organisations, and those that have mainly innovated by adopting innovations (for example new equipment) developed by other firms. Innovative firms can also be distinguished by the types of innovations they have implemented; they may have implemented a new product or process, or they may have implemented a new marketing method or organisational change.

48. Impacts of innovations on firm performance range from effects on sales and market share to changes in productivity and efficiency. Important

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impacts at industry and national levels are changes in international competitiveness and in total factor productivity, knowledge spillovers from firm-level innovations, and an increase in the amount of knowledge flowing through networks.

49. The outcomes of product innovations can be measured by the percentage of sales derived from new or improved products (see Chapter 7). Similar approaches can be used to measure the outcomes of other types of innovations. Additional indicators of the outcomes of innovation can be obtained through qualitative questions on the effects of innovations.

4.4. Linkages in the innovation process

50. The innovative activities of a firm partly depend on the variety and structure of its links to sources of information, knowledge, technologies, practices and human and financial resources. Each linkage connects the innovating firm to other actors in the innovation system: government laboratories, universities, policy departments, regulators, competitors, suppliers and customers. Innovation surveys can obtain information on the prevalence and importance of different types of linkages, and on the factors that influence the use of specific linkages.

51. Three types of external linkages are identified. *Open information sources* provide openly available information that does not require the purchase of technology or intellectual property rights, or interaction with the source. *Acquisition of knowledge and technology* results from purchases of external knowledge and capital goods (machinery, equipment, software) and services embodied with new knowledge or technology that do not involve interaction with the source. *Innovation co-operation* requires active co-operation with other firms or public research institutions on innovation activities (and may include purchases of knowledge and technology).

5. Some survey issues

5.1. *Approach to data collection*

5.2.1. Choice of the survey approach

52. There are two main approaches to collecting data on innovations:

i) The "subject" approach starts from the innovative behaviour and activities of the firm as a whole. The idea is to explore the factors influencing the innovative behaviour of the firm (strategies, incentives and barriers to innovation) and the scope of various innovation activities, and above all to examine the outputs and effects of innovation. These surveys are designed to be representative of all

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industries so that the results can be grossed up and comparisons made between industries.

ii) The "object" approach involves the collection of data about specific innovations (usually a "significant innovation" of some kind or a firm's main innovation). The approach involves collecting some descriptive, quantitative and qualitative data about the particular innovation at the same time that data is sought about the firm.

53. From the point of view of current economic development, it is the differential success of firms that shapes economic outcomes and is of policy significance. This favours a subject-based approach, although innovation surveys can combine both approaches by including general questions on the firm and specific questions on a single innovation. It is the subject, the firm, that is important, and this is the approach has been chosen as the basis for these guidelines.

5.2.2. *Survey methods*

54. To achieve international comparability of subject-based innovation surveys, it is important to harmonise survey methods. Guidelines are given in Chapter 8.

55. The target population for innovation surveys concerns statistical units (innovators and non-innovators, R&D performers and non-R&D performers) in the business enterprise sector, including both goods-producing and services sectors. Innovative activities take place in small and medium-sized units as well as in large units. To capture innovation activities in these smaller units, the target population should include, at a minimum, all statistical units with at least ten employees. In the case of sample surveys, the sample frames should correspond as closely as possible to the target population.

56. In order to ensure a satisfactory response rate, the questionnaire should be as short as possible and questions and instructions should be clearly formulated. This may involve expressing the formal definitions in Chapter 3 in ways that are appropriate and meaningful to respondents in the industry concerned.

57. In the data collection phase, particular attention should be paid to checking the reliability and consistency of data and to follow-up or reminder procedures. International comparability of the resulting data will be further improved by adopting uniform methods of imputing missing values, weighting factors, methods for presenting results, etc.

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6. The relationship between the *Oslo Manual* and other international standards and related concepts

6.1. Manuals for the measurement of science and technology activities

58. Two basic families of S&T indicators are directly relevant to the measurement of innovation: resources devoted to R&D and patent statistics. In addition, bibliometrics and several other types of indicators provide complementary information, although information is not always available at the firm level.

59. R&D data are collected through national surveys according to the guidelines laid down in the *Frascati Manual* (OECD, 2002). These data have proved valuable in many studies: for example, the effects of R&D on productivity have been estimated by econometric techniques, at the country, sector and firm levels. These data have two main limitations. First, R&D is an input. Although it is obviously related to technical change, it does not measure it. Second, R&D does not encompass all the efforts of firms and governments in this area, as there are other sources of technical change, such as learning by doing, which are not covered by this narrow definition.

60. A patent is a legal property right to an invention, which is granted by national patent offices. A patent gives its owner sole rights (for a certain duration) to exploit the patented invention; at the same time it discloses the details of the patent as a way to allow broader social use of the discovery. Patent statistics are increasingly used in various ways as indicators of the output of research activities. The number of patents granted to a given firm or country may reflect its technological dynamism; examination of the growth of patent classes can give some indication of the direction of technological change. The drawbacks of patents as innovation indicators are well-known. Many innovations are not patented, and some are covered by multiple patents; many patents have no technological or economic value, and others have very high value (see the *Patent Manual*, OECD, 1994).

61. These two basic families of statistics are complemented by several others: statistics on scientific publications (bibliometrics), publications in trade and technical journals ("LBIO" or literature-based indicators of innovation output), skilled human resources, the technology balance of payments, globalisation indicators, and activity in high-technology sectors (investment, employment, external trade). Moreover, some information on innovation and innovative activities can be drawn indirectly from many other sources, such as business surveys or education statistics.

62. The globalisation process affects innovation in a number of ways, through increases in international competition, in flows of goods, services and knowledge across national boundaries, and in international interactions.

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Multinational enterprises (MNEs) play a key role in this process. The *Handbook on Economic Globalisation Indicators* (OECD, 2005) discusses issues relating to globalisation and provides a set of relevant globalisation indicators.

63. Wherever possible, the Manual draws on the concepts and classifications set out in other volumes in the set of OECD manuals for the measurement of scientific and technological activities (see Box 1.2), especially the *Frascati Manual* on the resources devoted to R&D (OECD, 2002). This remark applies particularly to a number of questions on R&D and other S&T activities recommended for inclusion in innovation surveys in Chapter 6 and 7.

6.2. Other standards and classifications

Because of the need to place innovation in a wider context, both conceptually and in terms of databases, United Nations guidelines and classifications are used as far as possible, notably the System of National Accounts – SNA (CEC *et al.*, 1994) and the International Standard Industrial Classification – ISIC Rev. 3.1 (UN, 2002) and, as this is a joint OECD/Eurostat Manual, the corresponding European standards, notably the Statistical Classification of Economic Activities in the European Community – NACE Rev. 1.1 – series 2E.

Box 1.2. **Manuals and other guidelines for the measurement of scientific and technological activities**

Proposed Standard Practice for Surveys of Research and Experimental Development – Frascati Manual, sixth edition (OECD, 2002).

OECD Proposed Guidelines for Collecting and Interpreting Technological Innovation Data – Oslo Manual , third edition (OECD/EU/Eurostat, 2005).

"Using Patent Data as Science and Technology Indicators – *Patent Manual*" (OECD, GD 1994).

"The Measurement of Human Resources Devoted to S&T – *Canberra Manual*" (OECD/ EU/Eurostat, GD 1995).

"Proposed Standard Method of Compiling and Interpreting Technology Balance of Payments Data – *TBP Manual*" (OECD, GD 1992).

Handbook on Economic Globalisation Indicators (OECD, 2005).

Measuring Productivity Manual (OECD, 2001).

A Guide for Information Society Measurements and Analysis (OECD, 2005)

A Framework for Biotechnology Statistics (OECD, 2005).

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6.3. Other related concepts and surveys

64. As noted above, there are other ways of examining changes in firms that improve their productivity and performance. A few of the most relevant intangible investments are examined: the generation and adoption of information and communication technology (ICT), biotechnology and knowledge management.

65. *Information and communication technology* covers both hardware and software. Their development and diffusion is believed to have had a major impact on the pattern of production and employment in a wide range of industries. In the case of hardware it may be interesting not only to know when a company first introduces a technologically new or improved piece of ICT equipment but also the proportion of ICT in its total stock of equipment, including subsequent purchases of further machines of the same model. Mapping the development, production, adaptation and use of software is a more complex matter, as these activities are carried out throughout the economy. Surveys have been conducted both on uses of ICT and on R&D activity in firms developing ICT products.

66. While less pervasive than ICT, *biotechnology* is also increasingly expected to have a large economic impact, through increasing use of biotechnology to produce products and processes. A number of biotechnology surveys have been conducted, primarily on developers of biotechnology. However, some surveys have also examined biotechnology users (*e.g.* Statistics Canada, 1999).

67. *Knowledge management* involves activities related to the capture, use and sharing of knowledge by the organisation. It is an important part of the innovation process. A number of surveys have been conducted on knowledge management practices in recent years.[5] They cover policies and strategies, leadership, knowledge capture, training and communications, as well as reasons for using knowledge management practices and the reasons behind the development of such practices. In addition, questions on knowledge management have been included in innovation surveys.[6]

68. *Intangible investment* covers expenditures on non-routine marketing, training, software and some other similar items, in addition to current expenditure on R&D. It covers current expenditure on innovation but also comprises elements that are not part of current innovation expenditure (for example, all of a firm's training and marketing expenditure in general, not simply training or marketing in connection with the implementation of innovations). It does not cover tangible investment such as capital innovation expenditure, which includes capital expenditure on R&D, the acquisition of other machinery and equipment related to innovations.

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7. Final remark

69. The Manual is based on a consensus of views on the demand for innovation indicators and the underlying policy needs and economic theory, on the definitions and coverage of innovation and on the lessons to be learned from previous surveys. Managed jointly by OECD and Eurostat, it has been written for and by experts from some 30 countries that collect and analyse innovation data. Finding consensus has sometimes meant reaching compromises and agreeing to conventions. Furthermore, the complexity of the innovation process itself makes it difficult to establish absolutely precise guidelines. Nevertheless, the goal of the Manual is to provide a robust set of guidelines that can be used to produce meaningful indicators of innovation.

Notes

1. Experience covers the inclusion in innovation surveys of questions on marketing changes (the CIS3 survey, the Japanese National Innovation Survey 2003 and others). In addition, the Intangible Assets Survey 2004 in France included all four types of innovations (*i.e.* marketing, organisational, product and process) along with a number of other questions on marketing practices. The CIS4 survey, in progress at the time of publication of the Manual, also included all four types of innovations.
2. Earl (2003) is an example of early work in this area.
3. "Technological product and process (TPP) innovations comprise implemented technologically new products and processes and significant technological improvements in products and processes. A TPP innovation has been implemented if it has been introduced on the market (product innovation) or used within a production process (process innovation)." (OECD/Eurostat, 1997, §130.)
4. An exception would be an establishment-level survey, which could collect data on the first introduction of an innovation into each establishment.
5. See Foray and Gault (2003). In addition, a Eurostat pilot survey on knowledge management will be conducted in 2006.
6. For example, the CIS3 survey in France, the J-NIS 2003 survey in Japan, and the 2003 Innovation Survey in Australia.

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ISBN 92-64-01308-3
Oslo Manual: Guidelines for Collecting and Interpreting
Innovation Data

Chapter 2

Innovation Theory and Measurement Needs

1. Introduction

71. "The knowledge-based economy" is an expression coined to describe trends in advanced economies towards greater dependence on knowledge, information and high skill levels, and the increasing need for ready access to all of these by the business and public sectors. Knowledge and technology have become increasingly complex, raising the importance of links between firms and other organisations as a way to acquire specialised knowledge. A parallel economic development has been the growth of innovation in services in advanced economies.

72. Both innovation research and policy discussions emphasise the importance of taking a broad perspective on innovation. A "knowledge-based" view focuses on the interactive processes through which knowledge is created and exchanged both within and outside firms and other organisations. Many knowledge-intensive industries, such as high-technology manufacturing and business services, have grown strongly in many developed economies. Furthermore, a wide range of manufacturing and services industries have increased their use of knowledge-intensive technologies for production processes and service provision. While R&D plays a vital role in the innovation process, much innovation activity is not R&D-based, yet relies on highly skilled workers, on interactions with other firms and public research institutions, and on an organisational structure that is conducive to learning and exploiting knowledge.

73. The aim of this chapter is to examine theories and research on innovation and policy issues that are influenced by these theories, and to discuss how and to what extent innovation surveys can provide data on these issues. Innovation theory informs the design both of policy and measurement, and empirical analysis of data adds to our understanding of innovation, policy evaluation and the formation of new policy initiatives.

2. Economics of innovation

74. Research on innovation spans a number of disciplines, with economic approaches alone adopting several different theoretical perspectives, each of which offers significant insights. While these can be presented as alternatives, they can also be seen as complementary. This section evaluates the various theoretical approaches to innovation and assesses their implications for

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policy and data collection. The goal is to ensure that the design of innovation surveys results in obtaining data that are relevant for both theory and policy.

75. These theories address a number of innovation policy and measurement issues, such as why firms innovate, what forces drive innovation, and which factors hinder it. Related issues are the internal functioning of firms and the types of business practices used to promote innovation. Another important issue is the nature of knowledge, how it is accumulated, and how it flows between actors. A final issue is how innovation processes develop at the industry, regional or national levels.

76. The work of Joseph Schumpeter has greatly influenced theories of innovation. He argued that economic development is driven by innovation through a dynamic process in which new technologies replace the old, a process he labelled "creative destruction". In Schumpeter's view, "radical" innovations create major disruptive changes, whereas "incremental" innovations continuously advance the process of change. Schumpeter (1934) proposed a list of five types of innovations:

i) Introduction of new products.

ii) Introduction of new methods of production.

iii) Opening of new markets.

iv) Development of new sources of supply for raw materials or other inputs.

v) Creation of new market structures in an industry.

77. It is crucial to know why firms innovate. The ultimate reason is to improve firm performance, for example by increasing demand or reducing costs. A new product or process can be a source of market advantage for the innovator. In the case of productivity-enhancing process innovations, the firm gains a cost advantage over its competitors, allowing a higher mark-up at the prevailing market price or, depending on the elasticity of demand, the use of a combination of lower price and higher mark-up than its competitors to gain market share and increase profits. In the case of product innovation, the firm can gain a competitive advantage by introducing a new product, which allows it to increase demand and mark-ups.

78. Firms can also increase demand through product differentiation, by targeting new markets and by influencing demand for existing products. Changes in organisational methods can improve the efficiency and quality of their operations, thereby increasing demand or reducing costs.

79. Innovation can also improve performance by increasing the firm's ability to innovate. For example, improving the capabilities of production processes can make it possible to develop a new range of products, and new organisational practices can improve the firm's ability to gain and create new knowledge that can be used to develop other innovations.

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80. A Schumpeterian perspective tends to emphasise innovation as market experiments and to look for large, sweeping changes that fundamentally restructure industries and markets. Mainstream or neo-classical economics views innovation in terms of asset creation as well as market experiments. In this view, innovation is an aspect of business strategy, or part of the set of investment decisions to create capacity for product development or to improve efficiency. Recent developments have centred on the idea of "sunk costs", irrecoverable commitments of resources to enter new markets or to create competitive advantages by repositioning production or output in the value chain (Sutton, 1992, 1998).

81. Appropriation is an important factor in innovation, given that research results and new technologies often have aspects of a *public good*, as the costs of making them available to many users are low compared to their development costs. Once disseminated, users cannot be denied further access to such an innovation. In such cases, the firm cannot capture all the benefits generated by its innovation, which lessens the incentive to invest in innovation activities. Therefore, the ability to protect innovations will have an important influence on innovation activity.

82. Other work, notably in industrial organisation theory (*e.g.* Tirole, 1995), has emphasised the significance of competitive positioning. Firms innovate to defend their existing competitive position as well as to seek new competitive advantages. A firm may take a reactive approach and innovate to avoid losing market share to an innovative competitor. Or it may take a proactive approach to gain a strategic market position relative to its competitors, for example by developing and then trying to enforce higher technical standards for the products it produces.

83. The decision to innovate often takes place under great uncertainty (Rosenberg, 1994). Future developments in knowledge and technology, markets, product demand and potential uses for technologies can be highly unpredictable, although the level of uncertainty will vary by sector, the life cycle of a product and many other factors. The adoption of new products or processes or the implementation of new marketing or organisational methods are also fraught with uncertainty. Furthermore, the search for and collection of relevant information can be very time-consuming and costly.

84. Uncertainty can lead firms to hesitate to implement significant changes, even as they face a volatile environment that increases pressures to introduce new products, seek new markets and introduce new technologies, practices and organisational methods into their production processes. Uncertainty can also make it more difficult for firms to obtain external funding for their innovation projects.

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85. Literature on organisational innovation (*e.g.* Lam, 2005) focuses on the role of organisational structures, learning processes and adaptation to changes in technology and the environment (the latter includes the institutional framework and markets).

86. A firm's organisational structure can affect the efficiency of innovation activities, with some structures better suited to particular environments. For example, a greater degree of organisational integration may improve the co-ordination, planning and implementation of innovation strategies. Organisational integration can work particularly well in industries characterised by incremental changes in knowledge and technologies. A looser, more flexible form of organisation, which allows workers greater autonomy to make decisions and define their responsibilities, might be more effective in generating more radical innovations.

87. Organisational learning depends on practices and routines, patterns of interaction both within and outside the firm, and the ability to mobilise individual tacit knowledge and promote interaction. Such learning can be encouraged through careful design of practices, routines and relationships, or through a more flexible, fluid organisation in which individuals are encouraged to develop new ideas and ways of doing things.

88. Marketing theories (*e.g.* Hunt, 1983) focus on consumer behaviour, market exchanges between buyers and sellers, and normative approaches. As both buyers and sellers are heterogeneous, firms face the daunting challenge of matching their products to demand. The heterogeneity of consumers also means that product differentiation is often as important for capturing demand as the development of new products. Demand may depend not only on the objective characteristics of products, but also on their social characteristics and image, and firms can use these last two features to influence demand for their products. Normative marketing theories focus on the implementation of marketing practices. An example is the Marketing Mix Model (*e.g.* Perreault and McCarthy, 2005) that focuses on the "4 Ps" of marketing: product, price, promotion and placement.

89. *Product* involves changes in product design and packaging that are intended to change or enhance the product's appeal or to target a new market or market segment. *Price* involves the use of pricing methods to market goods or services. *Promotion* involves promotional efforts made by firms to improve their products' image or to increase awareness of their products. The final P, *placement*, involves both the types of sales channels that firms choose to sell their products and how these sales channels are designed in order to best market their products.

90. The diffusion of new knowledge and technology is a central part of innovation. The diffusion process often involves more than the mere adoption

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of knowledge and technology, as adopting firms learn from and build on new knowledge and technology. Theories of diffusion (*e.g.* Hall, 2005) focus on factors that affect firms' decisions to adopt new technologies, their access to new knowledge and their absorptive ability.

91. Sociological views on the diffusion of new technologies (*e.g.* Rogers, 1995) highlight firms' attributes that influence their decisions to adopt new knowledge or technologies, such as the relative advantage of the new technology, its compatibility with existing ways of doing things, its complexity, and the ease with which the firm is able to evaluate the new technology. Economic views on diffusion tend to focus on the costs and benefits of adopting new technologies. These potential benefits can often be strategic, so as to keep up with or gain an advantage over competitors.

92. Access to knowledge and technology can depend to a large extent on the connections between firms and organisations. This is particularly the case for the *tacit* knowledge that is held in the minds of people, or for information that is held in the "routines" of organisations. Direct interaction with the people with tacit knowledge or with access to routines is required in order to gain access to these types of knowledge.

93. Much knowledge is *codified* and can be accessed and used without direct interaction with the source. Transfers of codified knowledge comprise a large share of technology diffusion, and efforts to promote the codification of knowledge can have important impacts on productivity, growth and innovation. An example is work on the establishment of technology standards.

94. Even for information that is openly available, finding it can be a serious challenge, in particular since searching for new information can be very costly. Thus, ease of communication, effective channels of information and skills transmission, within and between organisations, are very important for diffusion.

95. Evolutionary approaches (Nelson and Winter, 1982) view innovation as a path-dependent process whereby knowledge and technology are developed through interaction between various actors and other factors. The structure of such interaction affects the future path of economic change. As an example, market demand and the opportunities for commercialisation influence which products are developed and which technologies are successful.

96. Closely linked to the evolutionary approach is the view of innovation as a system. The systems of innovation approach (Lundvall, 1992; Nelson, 1993) studies the influence of external institutions, broadly defined, on the innovative activities of firms and other actors. It emphasises the importance of the transfer and diffusion of ideas, skills, knowledge, information and signals of many kinds. The channels and networks through which this

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information circulates are embedded in a social, political and cultural background that guides and constrains innovation activities and capabilities. Innovation is viewed as a dynamic process in which knowledge is accumulated through learning and interaction. These concepts were initially introduced in terms of national systems of innovation, but they are also applicable to regional and international systems.

97. Systems approaches to innovation shift the focus of policy towards an emphasis on the interplay of institutions and look at interactive processes in the creation, diffusion and application of knowledge. They emphasise the importance of the conditions, regulations and policies in which markets operate and hence the role of governments in monitoring and seeking to fine tune this overall framework.

3. A measurement framework

98. These different theories form the basis for the innovation measurement framework used in the Manual. They highlight, among other things, the driving forces behind innovation, the importance not only of products and processes but also of marketing and organisational practices, the role of linkages and diffusion, and the view of innovation as a system.

99. The link between innovation and economic change is of central interest. Through innovation, new knowledge is created and diffused, expanding the economy's potential to develop new products and more productive methods of operation. Such improvements depend not only on technological knowledge, but also on other forms of knowledge that are used to develop product, process, marketing and organisational innovations. Specific types of innovation can differ greatly in their impact on firm performance and on economic change. For this reason, it is important to be able to identify the implementation and impacts of different types of innovation.

100. Figure 2.1 depicts this framework from the perspective of the firm, the target of innovation surveys. Other models of the innovation process, such as Kline and Rosenberg's chain-link model (Kline and Rosenberg, 1986) or the innovation dynamo (OECD/Eurostat, 1997), provide a useful theoretical overview for innovation processes but are less adapted to guiding survey design. The framework used in the Manual thus represents an integration of insights from various firm-based theories of innovation with those of approaches that view innovation as a system. The main characteristics of the framework described are:

- Innovation in the firm.
- Linkages with other firms and public research institutions.

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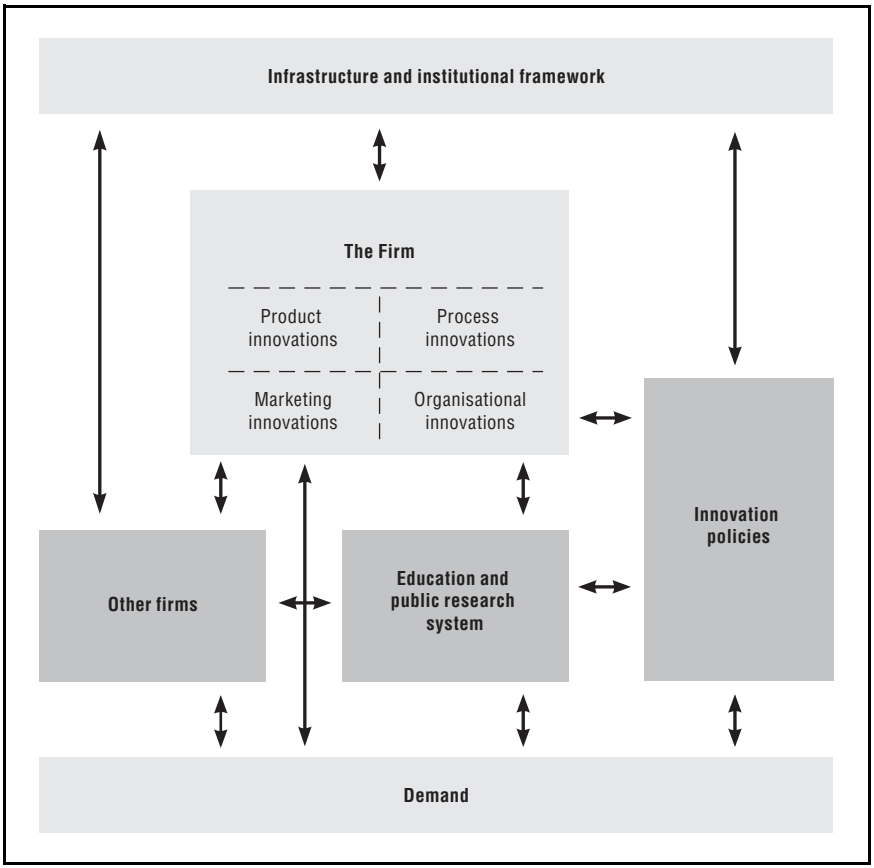
Figure 2.1. **The innovation measurement framework**



- The institutional framework in which firms operate.
- The role of demand.

101. Innovation in firms refers to planned changes in a firm's activities with a view to improving the firm's performance. Drawing on the discussion of innovation theory above, the concept of innovation used in the Manual refers to changes characterised by the following features:

a) Innovation is associated with *uncertainty* over the outcome of innovation activities. It is not known beforehand what the result of the innovation activities will be, *e.g.* whether R&D will result in the successful development of a marketable product or how much time and resources will be needed to implement a new production process, marketing or organisational method and how successful they will be.

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b) Innovation involves *investment*. Relevant investment can include acquisition of fixed and intangible assets as well as other activities (such as salaries, or purchase of material or services) that may yield potential returns in the future.

c) Innovation is subject to *spillovers*. The benefits of creative innovation are rarely fully appropriated by the inventing firm. Firms that innovate by adopting the innovation can benefit from knowledge spillovers or from the use of the original innovation. For some innovation activities, imitation costs are substantially lower than development costs, so that an effective appropriation mechanism to provide an incentive to innovate may be required.

d) Innovation involves the *utilisation of new knowledge* or a *new use or combination of existing knowledge*. New knowledge may either be generated by the innovating firm in the course of its innovation activities (*i.e.* through intramural R&D) or acquired externally through various channels (*e.g.* purchase of new technology). The use of new knowledge or the combination of existing knowledge requires innovative efforts that can be distinguished from standardised routines.

e) Innovation aims at improving a firm's performance by gaining a *competitive advantage* (or simply maintaining competitiveness) by shifting the demand curve of the firm's products (*e.g.* increasing product quality, offering new products or opening up new markets or groups of customers) or a firm's cost curve (*e.g.* reducing unit costs of production, purchasing, distribution or transaction), or by improving the firm's ability to innovate (*e.g.* increasing the ability to develop new products or processes or to gain and create new knowledge).

102. There are two main options open to a firm that wants to change its products, capabilities or production, marketing and organisational systems. It can invest in creative activities to develop innovations in house, either alone or in conjunction with external partners, or it can adopt innovations developed by other firms or institutions as part of a diffusion process. These two options offer countless combinations, as when a firm adopts an organisational innovation developed by another firm and adjusts it to function with its own work routines, or when it adapts new manufacturing technology to its production line, or when it introduces a new component obtained from a supplier into a consumer product. Both the creation and adoption of innovations can involve either intensive learning and interaction with other actors, or minimal external linkages.

103. The specific innovation activities that firms can use to develop or acquire innovations include R&D and/or many other activities that are summarised below.

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- **R&D:** R&D is defined in the *Frascati Manual* (OECD, 2002) and includes the following:
  - *i)* The firm can engage in basic and applied research to acquire new knowledge and direct research towards specific inventions or modifications of existing techniques.
  - *ii)* It can develop new product or process concepts or other new methods to assess whether they are feasible and viable, a stage which may involve: *a)* development and testing; and *b)* further research to modify designs or technical functions.
- **Other innovative activity:** The firm can engage in many non-R&D activities that can be part of innovation. These activities can strengthen capabilities that enable the development of innovations or the ability to successfully adopt innovations developed by other firms or institutions:
  - *iii)* It can identify new concepts for products, processes, marketing methods or organisational changes: *a)* via its marketing side and relations with users; *b)* via the identification of opportunities for commercialisation resulting from its own or others' basic or strategic research; *c)* via its design and development capabilities; *d)* by monitoring competitors; and *e)* by using consultants.
  - *iv)* It can buy technical information, paying fees or royalties for patented inventions (which usually require research and development work to adapt and modify the invention to its own needs), or buy know-how and skills through engineering, design or other consultancy services.
  - *v)* Human skills can be developed (through internal training) or purchased (by hiring); tacit and informal learning – "learning by doing" – may also be involved.
  - *vi)* It can invest in equipment, software or intermediate inputs that embody the innovative work of others.
  - *vii)* It can reorganise management systems and its overall business activities.
  - *viii)* It can develop new methods of marketing and selling its goods and services.

104. All these innovation activities have as their end objective the improvement of the firm's performance. They can be intended to develop and implement new products and processes, new methods of promoting and selling the firm's products and/or changes in the firm's organisational practices and structure.

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105. The general institutional environment determines the broad parameters within which firms operate. The component elements include:

- The *basic* ***educational*** *system for the general population*, which determines minimum educational standards in the workforce and the domestic consumer market.
- The ***university*** *system*.
- The *specialised* ***technical training*** *system*.
- The ***science and research*** *base*.
- *Common pools of* ***codified knowledge***, such as publications, technical, environmental and management standards.
- ***Innovation policies*** and other government policies that influence innovation by firms.
- ***Legislative*** *and macroeconomic settings* such as patent law, taxation, corporate governance rules and policies relating to interest and exchange rates, tariffs, and competition.
- The ***communications*** *infrastructure*, including roads and telecommunication networks.
- ***Financial*** *institutions* which determine, for example, the ease of access to venture capital.
- ***Market*** *accessibility*, including possibilities for the establishment of close relations with customers as well as matters such as size and ease of access.
- ***Industry structure*** *and the competitive environment*, including the existence of supplier firms in complementary sectors.

4. Sectoral and regional aspects of innovation

106. Innovation processes differ greatly from sector to sector in terms of development, rate of technological change, linkages and access to knowledge, as well as in terms of organisational structures and institutional factors (*e.g.* Malerba, 2005). Some sectors are characterised by rapid change and radical innovations, others by smaller, incremental changes.

107. In high-technology sectors, R&D plays a central role in innovation activities, while other sectors rely to a greater degree on the adoption of knowledge and technology. Differences in innovation activity across sectors (*e.g.* whether mainly incremental or radical innovations) also place different demands on the organisational structure of firms, and institutional factors such as regulations and intellectual property rights can vary greatly in their role and importance. It is important to take these differences into account when designing policy. They are also important for measurement, both when collecting data that allow for analysis across sectors and regions and when ensuring that the measurement framework is applicable to a broad range of industries.

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4.1. *Innovation in services*

108. The importance of innovation in the services sector and of the services sector's contribution to economic growth is increasingly recognised and has led to a number of studies on innovation in services (de Jong *et al.*, 2003; Hauknes, 1998; Howells and Tether, 2004; also Miles, 2005).

109. The services sector is diverse. Howells and Tether (2004) classify services into four groups: services dealing mainly with goods (such as transport and logistics), those dealing with information (such as call centres), knowledge-based services, and services dealing with people (such as health care). While this diversity should be kept in mind, several general characteristics apply to most services.

110. A key element of services is the distinction between products and processes is often blurred, with production and consumption occurring simultaneously. Development of processes can be more informal for services than for goods, with an initial phase consisting of search, idea gathering and commercial evaluation, followed by implementation.

111. Innovation activity in services also tends to be a continuous process, consisting of a series of incremental changes in products and processes. This may occasionally complicate the identification of innovations in services in terms of single events, *i.e.* as the implementation of a significant change in products, processes or other methods.

4.2. *Innovation in low- and medium-technology industries*

112. Innovation in low- and medium-technology industries (LMTs) often receives less attention than innovation in high-technology industries. However, innovation in LMTs can have a substantial impact on economic growth, owing to the weight of these sectors in the economy.

113. LMTs are generally characterised by incremental innovation and adoption. As such, innovation activities are often focused on production efficiency, product differentiation and marketing (Von Tunzelmann and Acha, 2005). An important aspect of innovation in these industries is the fact that it is more complex than the simple adoption of new technologies. In many cases, innovation activities in LMTs involve the incorporation of high-technology products and technologies. Prominent examples are the use of ICT and biotechnology (*e.g.* in food processing) in the development of new products and production processes. LMTs use and application of advanced technologies can place new demands on the skills of their workforce and can affect their organisational structure and their interactions with other firms and public research institutions.

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4.3. Innovation in small and medium-sized enterprises

114. Small and medium-sized enterprises (SMEs) are of necessity more specialised in their activities. This increases the importance of efficient interaction with other firms and public research institutions for R&D, exchange of knowledge and, potentially, for commercialisation and marketing activities.

115. Finance can be a determining factor for innovation in SMEs, which often lack internal funds to conduct innovation projects and have much more difficulty obtaining external funding than larger firms. Surveys can provide data on the degree to which financial constraints affect the ability of SMEs to innovate.

4.4. Regional innovation

116. The notion that regional factors can influence the innovative capacity of firms has led to increasing interest in analysing innovation at the regional level. Regional differences in levels of innovation activity can be substantial, and identifying the main characteristics and factors that promote innovation activity and the development of specific sectors at regional level can help in understanding innovation processes and be valuable for the elaboration of policy.

117. As a parallel to national innovation systems, regional innovation systems may develop. The presence, for example, of local public research institutions, large dynamic firms, industry clusters, venture capital and a strong entrepreneurial environment can influence the innovative performance of regions. These create the potential for contacts with suppliers, customers, competitors and public research institutions. Infrastructure also plays an important role.

4.5. Globalisation

118. National systems of innovation build on the idea that many of the factors that influence innovation activities are national, such as institutional factors, culture and values. At the same time, it is also clear that innovation processes are, in many ways, international. Technology and knowledge flow across borders. Firms interact with foreign firms and universities. Many markets, in terms of firms and their competitors, are global. The Internet has greatly enhanced opportunities for communicating and doing business with firms in other countries.

119. Multinational enterprises are a central factor in globalisation. Their activities transcend national boundaries as they involve international transfers of capital, knowledge and technology.

120. The globalisation process is also a powerful driving force for innovation. International competition forces firms to increase their efficiency

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and develop new products. Globalisation can also change the industrial structure of economies, pushing them to develop new industries and adapt their institutional frameworks.

5. Areas for investigation

121. It is essential to feed the policy debate with relevant information and analysis of many aspects of innovation. Ideally, a comprehensive information system should be constructed that covers all types of factors relevant to innovation policy and research. It would place governments in a strong position to deal appropriately with specific policy issues that may arise. In practice, only parts of such a system can be covered by indicators, while other parts call for qualitative information. Moreover, as policy and indicator analysts are well aware, indicators only occasionally relate neatly to a single factor or issue; more often than not they relate to a range of matters and only partially to each. Any broad information or monitoring system will need to be supplemented with case studies or specialised surveys when specific, in-depth analysis is required.

5.1. *What can be measured?*

122. Innovation surveys can provide a breadth of information on the innovation process at the firm level. They can identify motives and obstacles to innovation, changes in the way firms operate, the kinds of innovation activity that they engage in, and the types of innovations that they implement. In terms of the innovation process as a system, innovation surveys can provide information on firms' linkages with other actors in the economy and on the methods they use to protect their innovations. These areas are discussed in greater detail below.

123. There are also limitations to the types of data that can be obtained by innovation surveys. First, analysis will often require additional economic data on the firm, so that data from innovation surveys will often need to be combined with other information sources.

124. Second, innovation is a continuous process, and therefore difficult to measure, particularly for firms whose innovation activity is mainly characterised by small, incremental changes as opposed to single, well-defined projects to implement significant changes. Innovations are defined in the Manual as significant changes, with the intention of distinguishing significant changes from routine, minor changes. However, it is important to recognise that an innovation can also consist of a series of minor incremental changes.

125. Third, information on innovation expenditures is normally not specified in firms' financial accounts, making it difficult for firms to calculate them. While

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this does not preclude measuring innovation expenditures, these difficulties should be taken into account both in survey design and subsequent analysis.

126. Fourth, it is difficult for surveys to capture the timing of innovation activities, their implementation and their impact. Expenditures on innovation activities are intended to yield potential returns in the future. The outputs of these activities, from the development and implementation of innovations to improvements in innovative capacity to impacts on performance, are often not observable during the review period.

127. Finally, innovation surveys are not well placed to provide information on the general institutional environment, such as the education system, the labour market and financial systems, with the exception of how these institutional factors are experienced by the respondent firms.

5.2. Inputs to innovation

128. A broad understanding of the distribution of innovation activities across industries is of obvious importance for innovation policy. An important goal is to understand the role of R&D and non-R&D inputs in the innovation process and how R&D may be interrelated with other innovation inputs. Better information on the prevalence of non-R&D innovation inputs is particularly important for many services as they make use of R&D less frequently.

129. Innovation activities can lead both to the development and implementation of innovations over the short term and to improvements in the innovative capacity of the firm. The firm learns by developing and implementing innovations, gaining valuable inputs from interactions and marketing activity, and improving its innovative capacity through organisational changes.

130. Innovation surveys can provide both qualitative and quantitative data on firms' innovation inputs. Collecting quantitative data poses practical difficulties, especially when firms have many divisions, but data on innovation inputs are one of the most useful outputs of innovation surveys.

5.3. Linkages and the role of diffusion

131. Innovation surveys can provide data for use in analyses of technological change and productivity growth based on tracking flows of new knowledge and technologies from one industry to another. An example is the use of ICTs in a wide variety of products. How do firms incorporate new knowledge and innovations that have been developed elsewhere? Also, what is the relative weight of diffusion compared to creative innovation?

132. A separate but related issue concerns interactions both among organisations and between organisations and their surroundings. Systems approaches often highlight linkages as the most vital area for promoting

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innovation activity. It is important to determine both the types of interaction and the main sources of external knowledge.

133. These interactions can consist of informal contacts and information flows, or more formal collaboration on innovation projects. They include adjustments in the value chain, such as closer relationships with suppliers or users, or research on market demand or on the potential uses for technologies. Firms may have close relationships with other firms within an industry cluster or be part of looser networks. They may draw on published work from public research institutions or work directly with them on collaborative projects.

134. Innovation surveys can highlight the specific kinds of information of use for innovation and the types of institutions and transmission mechanisms that are available to firms. These include data on information sources, knowledge and technology flows, and collaborative partners as well as on barriers to innovation owing to a lack of information, for example on technologies or markets.

5.4. *The impact of innovation*

135. Of particular interest to innovation policy is the effect of innovation on output, productivity and employment, both at the national level and for specific sectors and regions. Better information on the conditions for success could help improve policies aimed at achieving the economic and social benefits of innovation.

136. Innovation surveys can provide both qualitative and quantitative data on the outcomes of innovations. In addition, survey data can very useful as input to subsequent empirical analyses of the impacts of innovation.

5.5. *Incentives and obstacles to innovation*

137. Many policies for supporting innovation would benefit from the identification of the main forces that drive firms' innovation activity. These forces can be market-related, concerned with increasing quality or efficiency, or involve adapting the firm's organisation to better fit its needs. Information on the objectives of innovation is readily obtained through innovation surveys.

138. Obstacles to innovation are significant for policy as well, since a good proportion of government measures are, in one way or another, aimed at overcoming them. Many obstacles – skill shortages, problems of competence, finance and appropriation – are relatively straightforward to assess with survey methods.

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5.6. *Demand*

139. Demand factors shape innovation activity in a number of ways. Demand affects the development of new products, as firms modify and differentiate products to increase sales and market share. Demand factors can force firms to improve their production and supply processes in order to reduce costs and lower prices. In many cases, they are also the main driver of innovation. Firms often spend substantial resources on researching demand and can adopt marketing measures to influence or create demand for their products. Market factors determine the commercial success of specific technologies or products and affect the path of technological change. They may also determine whether or not firms innovate. If firms do not believe that there is sufficient demand for new products in their market, they may decide either not to innovate or to delay innovation activities.

140. Both the measurement and analysis of the role of demand in innovation are problematic. It is very difficult to isolate demand effects from supply, and little is known about how to measure demand effects in surveys. Nevertheless, some aspects of demand may be covered in a survey, such as the extent to which innovations in products and services, and in the way they are provided, are driven through articulated customer requirements, or are supply-driven. The nature of customers and users is also a demand factor that the innovating firm takes into account. Some information can be obtained through innovation surveys in terms of the importance of market-related factors (both positive and negative) on innovation activity.

5.7. *Other*

5.7.1. *Human resources*

141. Much innovation knowledge is embodied in people and their skills, and appropriate skills are needed to make intelligent use of external sources or codified knowledge. The role of human capital in innovation is important at both the firm and the aggregate level. Some issues of interest here are the quality of the education system and how well it matches the needs of innovative firms and other organisations; what efforts firms make to invest in the human capital of their employees; whether innovation activity is hampered by shortages of qualified personnel; whether there are sufficient opportunities for worker training; and how adaptive the workforce is in terms of the structure of the labour market and mobility across regions and sectors. However, methods for measuring the role of human capital in innovation are not well developed, and limited information is available from innovation surveys.

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5.7.2. *Laws and regulations*

142. Laws and regulations are part of the framework in which firms operate. Well-designed regulations and standards can provide a strong signal to support and guide innovative activities. They affect access to information, property rights, tax and administrative burdens (in particular for small firms) and environmental standards. All are important for innovation policy, but policy needs can vary greatly from sector to sector.

143. For example, policies that reduce administrative barriers for SMEs can have a significant effect on innovation activity in smaller firms. Clear intellectual property rights are also vital for improving incentives to innovate in some industries. Innovation surveys can provide data on these issues through questions on obstacles to innovation and on the appropriation methods used by innovative firms.

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Oslo Manual: Guidelines for Collecting and Interpreting
Innovation Data

Chapter 3

Basic Definitions

1. Introduction

144. Based on the concepts presented in Chapter 2, this chapter aims to provide concise definitions for types of innovations, innovation activities and innovative firms.[1] Given the complexity of the innovation process and the variations in the way innovation occurs in firms, conventions have to be adopted in order to provide operational definitions that can be used in standardised surveys of firms.

145. The Manual distinguishes innovation in four areas: product, process, marketing and organisational. Product and process innovations are familiar concepts in the business sector, and were the sole focus of the previous editions of the Manual, in which organisational changes were covered in an annex and marketing innovations were not addressed. Both organisational and marketing innovations are extensively discussed in this edition of the Manual. Marketing and organisational innovations are familiar concepts to firms in some countries and have been included in some innovation surveys, although their definitions are generally not as well established as those for products and processes. The definitions of these new types of innovations for use in surveys are still under development, in much the same way as product and process innovations were in the first edition of the *Oslo Manual*.

2. Innovation

146. *An* ***innovation*** *is the implementation of a new or significantly improved product (good or service), or process, a new marketing method, or a new organisational method inbusiness practices, workplace organisation or external relations.*

147. This broad definition of an innovation encompasses a wide range of possible innovations. An innovation can be more narrowly categorised as the implementation of one or more types of innovations, for instance product and process innovations. This narrower definition of product and process innovations can be related to the definition of technological product and process innovation used in the second edition of the *Oslo Manual*.

148. The minimum requirement for an innovation is that the product, process, marketing method or organisational method must be *new (or significantly improved)to the firm*. This includes products, processes and methods that firms are the first to develop and those that have been adopted from other firms or organisations.

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149. ***Innovation activities*** *are all scientific, technological, organisational, financial and commercial steps which actually, or are intended to, lead to the implementation of innovations. Some innovation activities are themselves innovative, others are not novel activities but are necessary for the implementation of innovations. Innovation activities also include R&D that is not directly related to the development of a specific innovation.*

150. A common feature of an innovation is that it must have been *implemented*. A new or improved product is implemented when it is introduced on the market. New processes, marketing methods or organisational methods are implemented when they are brought into actual use in the firm's operations.

151. Innovation activities vary greatly in their nature from firm to firm. Some firms engage in well-defined innovation projects, such as the development and introduction of a new product, whereas others primarily make continuous improvements to their products, processes and operations. Both types of firms can be innovative: an innovation can consist of the implementation of a single significant change, or of a series of smaller incremental changes that together constitute a significant change.

152. *An* ***innovative firm*** *is one that has implemented an innovation during the period under review.*

153. The broad definition of an innovative firm may not be appropriate for all policy and research needs. More narrow definitions can be useful in many cases (see sections 7 and 8 of this chapter), particularly for comparisons of innovation across sectors, firm size categories or countries. An example of a more narrow definition is a product or process innovator.

154. *A* ***product/process innovative firm*** *is one that has implemented a new or significantly improved product or process during the period under review.* This definition, which includes all firms that have implemented a product or process innovation, is similar to the definition of the TPP innovative firm in the previous edition of the Manual.

3. Main type of innovation

155. Four types of innovations are distinguished: *product innovations, process innovations, marketing innovations* and *organisational innovations*. This classification maintains the largest possible degree of continuity with the previous definition of technological product and process innovation used in the second edition of the Manual. Product innovations and process innovations are closely related to the concept of technological product innovation and technological process innovation. Marketing innovations and organisational innovations broaden the range of innovations covered by the Manual as compared to the previous definition.

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156. *A **product innovation** isthe introduction of a good or service that is new or significantly improved with respect to its characteristics or intended uses. This includes significant improvements in technical specifications, components and materials, incorporated software, user friendliness or other functional characteristics.*

157. Product innovations can utilise new knowledge or technologies, or can be based on new uses or combinations of existing knowledge or technologies. The term "product" is used to cover both goods and services. Product innovations include both the introduction of new goods and services and significant improvements in the functional or user characteristics of existing goods and services.

158. *New* products are goods and services that differ significantly in their characteristics or intended uses from products previously produced by the firm. The first microprocessors and digital cameras were examples of new products using new technologies. The first portable MP3 player, which combined existing software standards with miniaturised hard-drive technology, was a new product combining existing technologies.

159. The development of a new use for a product with only minor changes to its technical specifications is a product innovation. An example is the introduction of a new detergent using an existing chemical composition that was previously used as an intermediary for coating production only.

160. *Significant improvements* to existing products can occur through changes in materials, components and other characteristics that enhance performance. The introduction of ABS braking, GPS (Global Positioning System) navigational systems, or other subsystem improvements in cars is an example of a product innovation consisting of partial changes or additions to one of a number of integrated technical subsystems. The use of breathable fabrics in clothing is an example of a product innovation involving the use of new materials that improves the performance of the product.

161. Product innovations in services can include significant improvements in how they are provided (for example, in terms of their efficiency or speed), the addition of new functions or characteristics to existing services, or the introduction of entirely new services. Examples are significant improvements in Internet banking services, such as greatly improved speed and ease of use, or the addition of home pick-up and drop-off services that improve customer access for rental cars. Providing on-site rather than remote management contact points for outsourced services is an example of an improvement in service quality.

162. Design is an integral part of the development and implementation of product innovations. However, design changes that do not involve a significant change in a product's functional characteristics or intended uses are *not* product innovations. However, they can be marketing innovations, as

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discussed below. Routine upgrades[2] or regular seasonal changes are also not product innovations.

163. *A **process innovation** is the implementation of a new or significantly improved production or delivery method. This includes significant changes in techniques, equipment and/or software.*

164. Process innovations can be intended to decrease unit costs of production or delivery, to increase quality, or to produce or deliver new or significantly improved products.

165. Production methods involve the techniques, equipment and software used to produce goods or services. Examples of new production methods are the implementation of new automation equipment on a production line or the implementation of computer-assisted design for product development.

166. Delivery methods concern the logistics of the firm and encompass equipment, software and techniques to source inputs, allocate supplies within the firm, or deliver final products. An example of a new delivery method is the introduction of a bar-coded or active RFID (Radio Frequency Identification) goods-tracking system.

167. Process innovations include new or significantly improved methods for the creation and provision of services. They can involve significant changes in the equipment and software used in services-oriented firms or in the procedures or techniques that are employed to deliver services. Examples are the introduction of GPS tracking devices for transport services, the implementation of a new reservation system in a travel agency, and the development of new techniques for managing projects in a consultancy firm.

168. Process innovations also cover new or significantly improved techniques, equipment and software in ancillary support activities, such as purchasing, accounting, computing and maintenance. The implementation of new or significantly improved information and communication technology (ICT) is a process innovation if it is intended to improve the efficiency and/or quality of an ancillary support activity.

169. *A **marketing innovation** is the implementation of a new marketing method involving significant changes in product design or packaging, product placement, product promotion or pricing.*

170. Marketing innovations are aimed at better addressing customer needs, opening up new markets, or newly positioning a firm's product on the market, with the objective of increasing the firm's sales.

171. The distinguishing feature of a marketing innovation compared to other changes in a firm's marketing instruments is the implementation of a marketing method not previously used by the firm. It must be part of a new marketing concept or strategy that represents a significant departure from the

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firm's existing marketing methods. The new marketing method can either be developed by the innovating firm or adopted from other firms or organisations. New marketing methods can be implemented for both new and existing products.

172. Marketing innovations include significant changes in *product design* that are part of a new marketing concept. Product design changes here refer to changes in product form and appearance that do not alter the product's functional or user characteristics. They also include changes in the packaging of products such as foods, beverages and detergents, where packaging is the main determinant of the product's appearance. An example of a marketing innovation in product design is the implementation of a significant change in the design of a furniture line to give it a new look and broaden its appeal. Innovations in product design can also include the introduction of significant changes in the form, appearance or taste of food or beverage products, such as the introduction of new flavours for a food product in order to target a new customer segment. An example of a marketing innovation in packaging is the use of a fundamentally new bottle design for a body lotion, which is intended to give the product a distinctive look and appeal to a new market segment.

173. New marketing methods in *product placement* primarily involve the introduction of new sales channels. Sales channels here refer to the methods used to sell goods and services to customers, and not logistics methods (transport, storing and handling of products) which deal mainly with efficiency. Examples of marketing innovations in product placement are the introduction for the first time of a franchising system, of direct selling or exclusive retailing, and of product licensing. Innovations in product placement can also involve the use of new concepts for the presentation of products. An example is the introduction of salesrooms for furniture that are redesigned according to themes, allowing customers to view products in fully decorated rooms.

174. New marketing methods in *product promotion* involve the use of new concepts for promoting a firm's goods and services. For example, the first use of a significantly different media or technique – such as product placement in movies or television programmes, or the use of celebrity endorsements – is a marketing innovation. Another example is branding, such as the development and introduction of a fundamentally new brand symbol (as distinguished from a regular update of the brand's appearance) which is intended to position the firm's product on a new market or give the product a new image. The introduction of a personalised information system, *e.g.* obtained from loyalty cards, to tailor the presentation of products to the specific needs of individual customers can also be considered a marketing innovation.

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175. Innovations in *pricing* involve the use of new pricing strategies to market the firm's goods or services. Examples are the first use of a new method for varying the price of a good or service according to demand (*e.g.* when demand is low, the price is low) or the introduction of a new method which allows customers to choose desired product specifications on the firm's Web site and then see the price for the specified product. New pricing methods whose sole purpose is to differentiate prices by customer segments are not considered innovations.

176. Seasonal, regular and other routine changes in marketing instruments are generally *not* marketing innovations. For such changes to be marketing innovations, they must involve marketing methods not previously used by the firm. For example, a significant change in a product's design or packaging that is based on a marketing concept that has already been used by the firm for other products is not a marketing innovation, nor is the use of existing marketing methods to target a new geographical market or a new market segment (*e.g.* socio-demographic group of clients).

177. *An* ***organisational innovation*** *is the implementation of a new organisational method in the firm's business practices, workplace organisation or external relations.*

178. Organisational innovations can be intended to increase a firm's performance by reducing administrative costs or transaction costs, improving workplace satisfaction (and thus labour productivity), gaining access to non-tradable assets (such as non-codified external knowledge) or reducing costs of supplies.

179. The distinguishing features of an organisational innovation compared to other organisational changes in a firm is the implementation of an organisational method (in business practices, workplace organisation or external relations) that has not been used before in the firm and is the result of strategic decisions taken by management.

180. Organisational innovations in *business practices* involve the implementation of new methods for organising routines and procedures for the conduct of work. These include, for example, the implementation of new practices to improve learning and knowledge sharing within the firm. An example is the first implementation of practices for codifying knowledge, *e.g.* establishing databases of best practices, lessons and other knowledge, so that they are more easily accessible to others. Another example is the first implementation of practices for employee development and improving worker retention, such as education and training systems. Other examples are the first introduction of management systems for general production or supply operations, such as supply chain management systems, business re-engineering, lean production, and quality-management systems.

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181. Innovations in *workplace organisation* involve the implementation of new methods for distributing responsibilities and decision making among employees for the division of work within and between firm activities (and organisational units), as well as new concepts for the structuring of activities, such as the integration of different business activities. An example of an organisational innovation in workplace organisation is the first implementation of an organisational model that gives the firm's employees greater autonomy in decision making and encourages them to contribute their ideas. This may be achieved through the decentralisation of group activity and management control or the establishment of formal or informal work teams in which individual workers have more flexible job responsibilities. However, organisational innovations may also involve the centralisation of activity and greater accountability for decision making. An example of organisational innovation in the structuring of business activities is the introduction for the first time of build-to-order production systems (integrating sales and production) or the integration of engineering and development with production.

182. New organisational methods in a firm's *external relations* involve the implementation of new ways of organising relations with other firms or public institutions, such as the establishment of new types of collaborations with research organisations or customers, new methods of integration with suppliers, and the outsourcing or subcontracting for the first time of business activities in production, procuring, distribution, recruiting and ancillary services.

183. Changes in business practices, workplace organisation or external relations that are based on organisational methods already in use in the firm are not organisational innovations. Nor is the formulation of managerial strategies in itself an innovation. However, organisational changes that are implemented in response to a new managerial strategy are an innovation if they represent the first implementation of a new organisational method in business practices, workplace organisation or external relations. For example, the introduction of a written strategy document to improve the efficient use of the firm's knowledge is not, by itself, an innovation. Innovation occurs when the strategy is implemented through the use of new software and practices for documenting information in order to encourage knowledge sharing among different divisions.

184. Mergers with, or the acquisition of, other firms are *not* considered organisational innovations, even if a firm merges with or acquires other firms for the first time. Mergers and acquisitions may involve organisational innovations, however, if the firm develops or adopts new organisation methods in the course of the merger or acquisition.

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4. Distinguishing between types of innovations

185. It is important for survey purposes to be able to distinguish between innovation types in borderline cases. However, many innovations may have characteristics that span more than one type of innovation. It can be both difficult and misleading, in terms of types of innovation activities undertaken by firms, to categorise these innovations as a single type. This section provides guidelines for distinguishing between the different types of innovations.

186. Collecting data on the different characteristics of an innovation that spans several innovation types will rarely create problems for interpretation and, in fact, will usually improve the quality of the results. For example, a firm that introduces a new product which also requires the development of a new process is clearly both a product and a process innovator. The same is true for a firm that introduces a new marketing method in order to market a new product, or a firm that adopts for the first time a new organisational method in the course of the introduction of a new process technology.

4.1. Distinguishing between product and process innovations

187. With respect to goods, the distinction between products and processes is clear. With respect to services, however, it may be less clear, as the production, delivery and consumption of many services can occur at the same time. Some distinguishing guidelines are:

- If the innovation involves new or significantly improved characteristics of the service offered to customers, it is a product innovation.
- If the innovation involves new or significantly improved methods, equipment and/or skills used to perform the service, it is a process innovation.
- If the innovation involves significant improvements in both the characteristics of the service offered and in the methods, equipment and/or skills used to perform the service, it is both a product and a process innovation.

In many cases, a service innovation may be only of one type. For example, firms can offer a new service or new characteristics of a service without significantly changing the method of providing the service. Likewise, significant process improvements, for instance to reduce delivery costs, may make no difference to the characteristics of the service that is sold to customers.

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4.2. Distinguishing between product innovations and marketing innovations

188. The main distinguishing factor for product and marketing innovations is a significant change in the product's functions or uses. Goods or services which have significantly improved functional or user characteristics compared to existing products are product innovations. On the other hand, the adoption of a new marketing concept that involves a significant change in the design of an existing product is a marketing innovation but not a product innovation, as long as the functional or user characteristics of the product are not significantly changed. As an example, clothes produced using new fabrics with improved performance (breathable, waterproof, etc.) are product innovations, but the first introduction of a new shape for clothes intended for a new group of customers or to give the product a higher degree of exclusivity (and thus allow for a higher mark-up compared to the previous version of the product), is a marketing innovation.

189. In some cases innovations can be considered both product and marketing innovations, if firms implement changes to existing products that involve both significant changes in the functions or uses of the product and significant changes in the product's form and appearance or packaging which are part of a new marketing concept.

4.3. Distinguishing between service (product) innovations and marketing innovations

190. The main distinguishing factor for service innovations and marketing innovations is whether the innovation involves a marketing method or a service (*i.e.* a product). Firms will generally be able to distinguish between their sales/marketing methods and their products.

191. The distinction may depend on the nature of the firm's business. An example is an innovation involving Internet sales. For a firm that produces and sells goods, the introduction of e-commerce for the first time is a marketing innovation in product placement. Firms that are in the business of e-commerce (*e.g.* "auction" firms, Web site providers that allow other firms to advertise or sell their products, firms arranging the sale of travel tickets, etc.) are offering "sales services". For these firms, a significant change in the characteristics or capabilities of their Web site is a product (service) innovation.

192. Some innovations are both product and marketing innovations, for example, if a firm implements a new sales and customer service operation, introducing both a new way of marketing its products (direct selling) while also offering additional services (*e.g.* repair) and product information to customers.

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4.4. *Distinguishing between process and marketing innovations*

193. Both process and marketing innovations can involve new methods of moving information or goods, but their purposes differ. Process innovations involve production and delivery methods and other ancillary support activities aimed at decreasing unit costs or increasing product quality, while marketing innovations aim at increasing sales volumes or market share, the latter through changes in product positioning or reputation.

194. Borderline cases can arise for marketing innovations that involve the introduction of new sales channels. For example, innovations that involve the introduction of a new sales channel (*i.e.* a new way of selling goods and services to customers) may also include the implementation of new logistics methods (*i.e.* the transport, storage and handling of products). If these innovations are aimed both at increasing sales and reducing unit distribution costs, they should be considered both process and marketing innovations.

4.5. *Distinguishing between process and organisational innovations*

195. Distinguishing between process and organisational innovations is perhaps the most frequent borderline case for innovation surveys since both types of innovation attempt – among other things – to decrease costs through new and more efficient concepts of production, delivery and internal organisation. Many innovations thus contain aspects of both types of innovation. For example, the introduction of new processes may also involve the first use of new organisational methods such as group working. Organisational innovations such as the first introduction of a total quality management system may involve significant improvements in production methods, such as new production logistic systems, to avoid certain types of flaws or new and more efficient information systems based on new software and new ICT equipment.

196. A starting point for distinguishing process and/or organisational innovations is the type of activity: process innovations deal mainly with the implementation of new equipment, software and specific techniques or procedures, while organisational innovations deal primarily with people and the organisation of work. Guidelines for distinguishing the two in borderline cases are as follows:

- If the innovation involves new or significantly improved production or supply methods that are intended to decrease unit costs or increase product quality, it is a process innovation.
- If the innovation involves the first use of new organisational methods in the firm's business practices, workplace organisation or external relations, it is an organisational innovation.

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- If the innovation involves both new or significantly improved production or supply methods and the first use of organisation methods, it is both a process and an organisational innovation.

4.6. Distinguishing between marketing and organisational innovations

197. Borderline cases may arise for innovations that involve the introduction for the first time of both marketing and organisational methods. As noted above, if an innovation has characteristics of both types of innovations, then it is both a marketing innovation and an organisational innovation. However, organisational innovations that involve sales activities (*e.g.* the integration of sales with other departments), but do not involve the introduction of new marketing methods, are not marketing innovations.

5. Changes which are not considered innovations

5.1. Ceasing to use a process, a marketing method or an organisation method, or to market a product

198. It is not an innovation to stop doing something, even if it improves a firm's performance. For example, it is not an innovation when a television manufacturer ceases to produce and sell a combined television and DVD player, or a property development agency or construction company stops building retirement villages. Similarly, ceasing to use a certain marketing or organisational method is not an innovation.

5.2. Simple capital replacement or extension

199. The purchase of identical models of installed equipment, or minor extensions and updates to existing equipment or software, are not process innovations. New equipment or extensions must both be new to the firm and involve a significant improvement in specifications.

5.3. Changes resulting purely from changes in factor prices

200. A change in the price of a product or in the productivity of a process resulting exclusively from changes in the price of factors of production is not an innovation. For example, an innovation does not occur when the same model of PC is constructed and sold at a lower price simply because the price of computer chips falls.

5.4. Customisation

201. Firms engaged in custom production make single and often complex items according to customers' orders. Unless the one-off item displays significantly different attributes from products that the firm has previously made, it is not a product innovation.

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202. Note that the above concerns product changes from customisation and not the implementation of customised production itself. For example, the integration of production, sales and delivery operations is an organisational innovation.

5.5. *Regular seasonal and other cyclical changes*

203. In certain industries such as clothing and footwear there are seasonal changes in the type of goods or services provided which may be accompanied by changes in the appearance of the products concerned. These types of routine changes in design are generally neither product nor marketing innovations. For example, the introduction of the new season's anoraks by a clothing manufacturer is not a product innovation unless the anoraks have, for example, a lining with significantly improved characteristics. However, if the occasion of seasonal changes is used for a fundamental change in product design that is part of a new marketing approach used for the first time by the firm, this should be considered a marketing innovation.

5.6. *Trading of new or significantly improved products*

204. The situation for new products is complicated in the goods-handling services and distributive trades (wholesale and retail distribution, transport and storage). Trading of new or improved products is generally not a product innovation for the wholesaler, retail outlet or transport and storage firm. However, if such a firm begins to deal with a new line of goods (*i.e.* types of goods that the firm has not previously sold) then this activity is to be considered a product innovation, as the firm is offering a new service.

6. Novelty and diffusion

205. By definition, all innovations must contain a degree of novelty. Three concepts for the novelty of innovations are discussed below: new to the firm, new to the market, and new to the world.

206. The developer of the innovation, discussed in Chapter 5, is also related to novelty and diffusion and establishes whether innovations are mainly developed within enterprises themselves or in co-operation with other enterprises or public research institutions, or whether they are mainly developed outside the enterprise.

207. As noted above, the minimum entry level for an innovation is that it must be *new to the firm*. A product, process, marketing method or organisational method may already have been implemented by other firms, but if it is new to the firm (or in case of products and processes: significantly improved), then it is an innovation for that firm.[3]

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208. The concepts *new to the market* and *new to the world* concern whether or not a certain innovation has already been implemented by other firms, or whether the firm is the first in the market or industry or worldwide to have implemented it. Firms that first develop innovations can be considered drivers of the process of innovation. Many new ideas and knowledge originate from these firms, but the economic impact of the innovations will depend on the adoption of the innovations by other firms. Information on the degree of novelty can be used to identify the developers and adopters of innovations, to examine patterns of diffusion, and to identify market leaders and followers.

209. Innovations are new to the market when the firm is the first to introduce the innovation on its market. The market is simply defined as the firm and its competitors and it can include a geographic region or product line. The geographical scope of new to the market is thus subject to the firm's own view of its operating market and thus may include both domestic and international firms.

210. An innovation is new to the world when the firm is the first to introduce the innovation for all markets and industries, domestic and international. New to the world therefore implies a qualitatively greater degree of novelty than new to the market. While many surveys may find that questions on new to the market are sufficient to examine the degree of novelty for innovations, new to the world provides an option for surveys that wish to examine novelty in greater detail.

211. A related concept is a radical or disruptive innovation. It can be defined as an innovation that has a significant impact on a market and on the economic activity of firms in that market. This concept focuses on the impact of innovations as opposed to their novelty. The impact can, for example, change the structure of the market, create new markets or render existing products obsolete (Christensen, 1997). However, it might not be apparent whether an innovation is disruptive until long after it has been introduced. This makes it difficult to collect data on disruptive innovations within the period reviewed in an innovation survey.

7. The innovative firm

212. The innovative status of a firm can be defined in several ways. The basic definition of an innovative firm (see Section 2) is a firm that has implemented at least one innovation, while a product or process innovator is defined as a firm that has implemented either a product or a process innovation.

213. Further ways of classifying an innovative firm are possible, depending on policy or research needs. They can be used to specify the percentage of firms (by size class, sector, country or other factor) that introduces each of the

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four types of innovations, or the share of firms that have implemented combinations of innovations, such as product and marketing innovations or process and organisational innovations. Classification by innovative status can also include other information, for example about the developer of the innovation, which may be used to identify firms that only adopt product and process innovations developed by other firms.

214. Firms may have innovation activities in the period under review without having actually implemented an innovation. All activities involved in the development or implementation of innovations, including those planned for implementation in the future, are innovation activities (see Section 2). During a given period, innovation activities can be of three kinds:

- *Successful* in having resulted in the implementation of an innovation (although the innovation need not have been commercially successful).
- *Ongoing*, for work in progress which has not yet resulted in the implementation of an innovation.
- *Abandoned* before the implementation of an innovation.

Innovation activities are specified in detail in Chapter 6.

215. *An **innovation-active firm** is one that has had innovation activities during the period under review, including those with ongoing and abandoned activities.* In other words, firms that have had innovation activities during the period under review, regardless of whether the activity resulted in the implementation of an innovation, are innovation-active.

216. Firms can have come into existence during the period under review. These include both newly established firms and firms that are the result of mergers, demergers or other kinds of reorganisation. The innovation status of these firms, such as whether they are innovative or innovation-active, is defined in the same way as for all other firms.

8. Collecting data on innovations

217. Depending on survey objectives and scope, data collection on innovations can take various approaches. A comprehensive approach would cover all four types of innovations equally. Alternatively, product and process innovations might be maintained as the core innovation types but marketing and organisational innovations might be partly covered, or product and process innovations might be the exclusive focus. In addition, one or more types of innovation can be covered in greater detail through specialised surveys.

218. The guidelines presented here and in subsequent chapters outline a number of options for data collection. Clearly, it is not feasible to cover all topics and subtopics in one innovation survey, and surveys must choose the

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questions that are deemed most relevant. A limited set of topics which are considered particularly important for innovation surveys are recommended in bold type.

219. Data on each type of innovation can be collected through a single question or through a series of sub-questions on separate subgroups of each type of innovation. The latter option will result in more detailed information on the innovations of each firm. Greater detail on the types of innovations firms have implemented would be very useful for data analysis and interpretation.

220. Information on supplementary factors, such as linkages, innovation objectives and barriers to innovation, can be collected separately for each type of innovation, or for closely related subsets of the four types, such as a combination of product and process innovation. For some supplementary questions, collecting data for all four types of innovation combined can make interpretation of the data more difficult. For example, combining all four types of innovation in questions on linkages would make it very difficult to determine if a specific linkage was used in developing a product, process, marketing or organisational innovation.

221. Length constraints make separate questions on each supplementary factor for each type of innovation somewhat problematic. Taking this into account, Chapters 6 and 7 outline options for supplementary questions: referring to all four types of innovations combined, focusing on product and process innovations, or directing questions at individual types of innovations. Chapter 5 provides guidelines for directing questions on linkages towards all four types (either combined or separately) or to a subset of types, such as product and process innovations. Chapter 6 separates product and process innovation activities from activities for marketing and organisational innovations. Chapter 7 lists objectives, hindering factors and other indicators for each individual type of innovation. These lists can be equally useful for questions that focus solely on a subset of innovations, either those that cover all innovation types, or those that cover individual types of innovations.

222. Innovations spanning more than one type, such as those including both a process and an organisational component, might play an increasingly important role in firm competitiveness and in productivity gains. For example, a restructuring of production operations could involve process, organisational and marketing innovations, or a marketing and organisational innovation could be implemented in order to better profit from a product innovation.

223. One option is to include questions on the connections between different types of innovations. Of particular interest is the link between organisational and process innovations, although connections between other types, such as product and marketing innovations or product and process innovations, can also be of interest.

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224. To ensure comparability, surveys must specify an observation period for questions on innovation. **It is recommended that the length of the observation period for innovation surveys should not exceed three years or be less than one year.** Factors influencing the choice of the length of the observation period are discussed in Chapter 8 on survey methods. The same observation period should be used for all questions in an innovation survey, with the exception of a few quantitative indicators that are difficult to collect and should therefore refer to the most recent year of the observation period, the **reference year**.

225. The concept of novelty is in principle applicable to all four types of innovations, possibly to differing degrees. Questions on novelty are likely to be easiest to answer for product innovations. Firms may find questions on the novelty of process innovations more difficult, as they may lack full knowledge of other firms' production and delivery methods. The concept of novelty is applicable for most marketing innovations (such as new methods in contracting, product placement and product promotion), though less relevant for new concepts of product design. For organisational innovation, some new organisational methods may be specific to an individual firm, thereby complicating comparison with other firms, and firms may lack information on whether certain organisational methods have already been applied by other firms.

226. **It is recommended that innovation surveys ask whether any product innovations introduced during the observation period were new to the market.** Innovation surveys can also collect data on new to the market process innovations. An additional option is to ask whether these types of innovations were new to the world.

Notes

1. In this chapter, the generic term, "the firm", is used. The primary statistical unit for collecting data, which in general is the enterprise, is discussed in Chapter 4. In particular, the question of what is "new to the firm" becomes more complicated when considering large enterprise groups or multinational enterprises. These issues will be considered in Chapter 4.
2. A routine upgrade involves minor changes to a good or service that are expected and planned for in advance. The development of the upgrade is also based on routine, well-established activities. For example, anti-virus software is purchased with the expectation of frequent upgrades to cover the appearance of new viruses. A hotel chain will construct new hotels with the expectation that furnishings, lamps and bathroom fixtures will be upgraded on a regular basis, even though this may be on a 10- or 20-year cycle.
3. By "firm" is meant, the statistical unit for which data is compiled, which in general is the *enterprise*. *New to the firm* thus implies new to the statistical unit.

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Chapter 4

Institutional Classifications

1. The approach

227. The institutional approach focuses on the characteristic properties of the innovative firm. All characteristics of innovation activities, and their inputs and outputs, are classified to one class or subclass according to the unit's principal activity.

2. The units

228. A clear distinction should be made between the reporting unit, the observation unit and the statistical unit. The **reporting unit** is the entity from which the recommended items of data are collected. They may vary from sector to sector and from country to country, depending on institutional structures, the legal status of data collection, tradition, national priorities and survey resources. It is therefore difficult to make international recommendations about the reporting unit for innovation surveys. However, whenever countries provide statistics for international comparisons, the reporting units should be specified.

229. The **observation unit** is the entity that the received data refer to. The observation unit is equivalent to the reporting unit if the data received refer to the same unit as the reporting unit.[1] The **statistical unit** may be an observation unit on which information is received and statistics are compiled, or an analytical unit which statisticians create by splitting or combining observation units with the help of estimations or imputations in order to supply more detailed and/or homogeneous data than would otherwise be possible.

230. As far as possible, the statistical unit should be uniform for all countries. This goal may, however, be difficult to achieve in practice. One reason is that legal structures differ from country to country. Definitions of units, such as the enterprise, may also vary across countries. Another reason is the interaction of the statistical unit with the observation or reporting unit. If the reporting or the observation unit is larger than the statistical unit, there may be problems in distributing the data into the appropriate statistical units.

231. **Ideally, innovation data should be compiled (and collected) at the organisational level for which decisions on innovation activity are made. Taking into account how innovation activities are usually organised, the enterprise is in general the most appropriate statistical unit**. However, no

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single definition of an enterprise is used in all countries. The two main definitions are those of the ISIC and the EU. According to ISIC Rev. 3.1, §§ 54-55, an enterprise has "autonomy in respect of financial and investment decision making, as well as authority and responsibility for allocating resources for the production of goods and services. It may be engaged in one or many productive activities. The enterprise is the level at which financial and balance sheet accounts are maintained and from which international transactions, and international investment position (when applicable) and the consolidated financial position can be derived". The EU definition of an enterprise is somewhat narrower: "The enterprise is the smallest combination of legal units that is an organisational unit producing goods or services, which benefits from a certain degree of autonomy in decision making, especially for the allocation of its current resources. An enterprise carries out one or more activities at one or more locations."[2]

232. While the two definitions are very similar, a central difference is that a group of enterprises is not an enterprise according to the EU definition (since it does not comprise the smallest combination of legal units that is an organisational unit), while an enterprise group still falls within the ISIC definition of an enterprise. Common characteristics are that enterprises exercise a certain degree of autonomy in decision making and have full financial accounts.

2.1. The primary statistical unit

233. The **enterprise unit** is the appropriate primary statistical unit in innovation surveys in most cases. The enterprise unit should, however, not be confused with the entity "legal unit". While legal units are independent in a legal sense, they may not necessarily constitute independent economic entities with decision-making autonomy for their productive activities. This point follows from the EU definition of an enterprise and ISIC Rev. 3.1, §49.[3] This is important for samples drawn from business registers based on legal units, as data from legal units without decision-making autonomy may not be comparable with data from enterprises. If data are collected for legal units, it is desirable to compile the data for statistical use at the enterprise level.

234. **The enterprise is generally the most appropriate statistical unit.** It includes:

- Enterprises that consist of a single legal unit that engages primarily in one kind of economic activity.
- Enterprises that are a group of legal units, where the individual legal units cannot be considered separate economic entities, including:
  - ❖ Legal units that are vertically or horizontally integrated in the enterprise.
  - ❖ Individual legal units that perform ancillary functions, including R&D.

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235. Some cases require greater clarification. These include: *i)* enterprise groups; *ii)* large enterprises that may have several areas of activity and *iii)* multinational enterprises and groups.

236. An enterprise group is an association of enterprises bound together by legal and/or financial links. For such groups, the question of whether innovation data should be compiled at the group level or for each individual enterprise depends on the level at which decisions on innovation activity are made. If each individual enterprise unit has decision-making autonomy concerning innovation, it is preferable to collect and compile data at the enterprise level as opposed to the group level.

237. Large enterprises may have a number of different productive activities. For the largest, decision making on innovation activity will likely not be made at the highest level of the organisation, but undertaken for each productive activity or division. In this case, it may be preferable, where possible, to collect and compile data at the level of the kind of activity unit (KAU), defined as "an enterprise or part of an enterprise which engages in one kind of economic activity without being restricted to the geographic area in which that activity is carried out".[4] This means that the KAU may consist of one or more legal units, or a part of a legal unit.

238. Multinational enterprises (MNEs) present a number of challenges, given that many activities may take place across national borders. For example, innovation activities in MNEs may be undertaken jointly by units in more than one country, and many activities may be segmented, with development activities in one country and production and sales in another. Given that innovation surveys are national surveys, data will be limited to domestic unit(s) of the MNE. However, it can be very useful to obtain as much information as possible on connections between the domestic unit's innovation activities and those of units abroad. The following guidelines are suggested for treating MNEs:

- The domestic part of the multinational enterprise alone represents the statistical unit to be included, regardless of the location of the enterprise's headquarters. Data may be collected on whether observation units are part of MNEs (see below).
- Foreign units of an MNE should be regarded as a separate entities (not part of the statistical unit, though belonging to the same enterprise group):
  - ❖ Joint innovation activities between the domestic and foreign units of the MNE should be considered as innovation co-operation between two enterprises in the same enterprise group. Exchanges of information or purchases of knowledge and technology should also be treated as transfers between two separate enterprises.

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- ❖ R&D activity that is conducted abroad or other new knowledge and technology acquired abroad (and included in the accounts of the MNE's domestic unit) should be included in "Extramural R&D" and "Acquisition of external knowledge", respectively (see Chapter 6).
- ❖ For questions on the developer of an innovation, "other enterprises" can be broken down into those that are part of a MNE or enterprise group, and all other enterprises.
- ❖ Innovations developed by the foreign units of a multinational enterprise and adopted by the domestic units are innovations that are new to the firm.
- ❖ Innovations developed by foreign units, but not adopted by the domestic units of a multinational enterprise, should not be included.

239. **Guidelines for the primary statistical unit are summarised below**:

The most appropriate primary statistical unit is the enterprise, including:

- Enterprises that are single legal units with one primary economic activity.
- Enterprises that are groups of legal units that cannot be considered separate economic entities.
- Enterprises that are part of an enterprise group, where decision making on innovation takes place at the enterprise level:
  - ❖ In some cases for very large enterprises with more than one economic activity, the appropriate primary statistical unit can be kind of activity units (KAU), with the KAU consisting of one or more legal units, or part of a legal unit.
  - ❖ For MNEs, the domestic units of multinational enterprises are the appropriate statistical units, and may either be an enterprise or part of an enterprise (*e.g.* a legal unit).

240. Based on the discussions above, **it is recommended that data be collected on the institutional status of the observation unit:**

- Whether the observation unit is part of an enterprise or enterprise group and, if so, its function: for example, headquarters, research centre, administrative centre, marketing, other.
- Whether the observation unit is part of a multinational enterprise and, if so, its function and where the headquarters is located.

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2.2. The secondary statistical unit

241. In some instances, there may be interest in collecting data at a lower organisational level than the enterprise. This may for example be the case for compiling regional statistics or for employing a two-tiered approach to data collection.

242. In such cases, an appropriate secondary statistical unit is the **establishment unit**, which can be defined (following ISIC Rev. 3.1) as: "an enterprise or part of an enterprise, that is situated in a single location, and in which only a single (non-ancillary) productive activity is carried out or in which the principal productive activity accounts for most of the value added". An alternative is the local unit as defined by the EU.[5] The secondary statistical unit may be useful for larger enterprises that have operations in more than one region.

243. For regional analysis, the establishment unit or similar units may be useful[6] for collecting innovation data. However, information on some variables should not be collected at the level of establishment (or similar) units as they refer directly to the enterprise. An example is information on innovation objectives, which refers to strategic decisions at the enterprise level which are rarely taken by establishment units.

244. For large enterprises in particular, decisions on innovation activities may be decentralised and it may be difficult for one person to provide data on all innovation activities in the enterprise. An option in this case is to use a *two-tiered approach* to data collection. More than one method can be used. One is to collect data at the establishment level and then compile the data at the enterprise level. Regional- or establishment-level analysis can rely on the collected establishment-level data. A drawback is that, as mentioned above, establishments may not be in a position to respond to all questions on innovation. The second method is to collect some innovation data at the enterprise level and other data at the establishment level. How this method is used in practice may depend on the preferences of the management of each enterprise.

245. Care should be taken in aggregating establishment results to the enterprise level. For example, the introduction of a new technology can be an innovation for an establishment but not for the enterprise if it already has been used elsewhere in the enterprise.

3. Classification by main economic activity

246. Statistical units of innovation surveys can be broken down according to different classifications. The most important classification is the **principal economic activity of the statistical unit** ("industry"). The International Standard Industrial Classification (ISIC Rev. 3.1) and the statistical classification of economic activities in the European Community (NACE Rev. 1.1)[7] are appropriate international classifications for this purpose.

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Table 4.1. **Industrial classification proposed for innovation surveys in the business enterprise sector based on ISIC Rev. 3.1 and NACE Rev. 1.1**

Title	ISIC Rev. 3.1 Division/Group/Class	NACE Rev. 1.1 Division/Group/Class
MINING AND QUARRYING	10 to 14	10 to 14
MANUFACTURING	15 to 37	15 to 37
Food products and beverages	15	15
Tobacco products	16	16
Textiles	17	17
Wearing apparel and fur	18	18
Leather products and footwear	19	19
Wood and cork (not furniture)	20	20
Pulp, paper and paper products	21	21
Publishing, printing and reproduction of recorded media	22	22
Coke, refined petroleum products and nuclear fuel	23	23
Chemicals and chemical products	24	24
Chemical products less pharmaceuticals	24 less 2423	24 less 24.4
Pharmaceuticals	2423	24.4
Rubber and plastic products	25	25
Non-metallic mineral products	26	26
Basic metals	27	27
Basic metals, ferrous	271 + 2731	27.1 to 27.3 + 27.51/52
Basic metals, non-ferrous	272 + 2732	27.4 + 27.53/54
Fabricated metal products (except machinery and equipment)	28	28
Machinery n.e.c.	29	29
Office, accounting and computing machinery	30	30
Electrical machinery	31	31
Electronic equipment (radio, TV and communications)	32	32
Electronic components (includes semiconductors)	321	32.1
Television, radio and communications equipment	32 less 321	32 less 32.1
Medical, precision and optical instruments, watches, clocks (instruments)	33	33
Motor vehicles	34	34
Other transport equipment	35	35
Ships	351	35.1
Aerospace	353	35.3
Other transport n.e.c.	352 + 359	35.2 + 35.4 + 35.5
Furniture, other manufacturing n.e.c.	36	36
Furniture	361	36.1
Other manufacturing n.e.c.	369	36.2 to 36.6
Recycling	37	37
Electricity, gas and water supply	40 + 41	40 + 41

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Table 4.1. **Industrial classification proposed for innovation surveys in the busines enterprise sector based on ISIC Rev. 3.1 and NACE Rev. 1.1** *(cont.)*

Title	ISIC Rev. 3.1 Division/Group/Class	NACE Rev. 1.1 Division/Group/Class
Construction	45	45
Marketed services	50 to 74	50 to 74
Sale, retail, maintenance and repair of motor vehicles and motorcycles	50	50
Other wholesale trade	51	51
Other retail trade	52	52
Hotels and restaurants	55	55
Land transport and via pipelines	60	60
Water transport	61	61
Air transport	62	62
Supporting and auxiliary transport activities, travel agencies	63	63
Post and telecommunications	64	64
Post	641	64.1
Telecommunications	642	64.2
Financial intermediation	65 to 67	65 to 67
Real estate, renting	70 + 71	70 + 71
Computer and related activities	72	72
Software consultancy and supply	722	72.2
Other computer services n.e.c.	72 less 722	72 less 72.2
Research and development[1]	73	73
Other business activities	74	74
Architectural, engineering and other technical activities	742	74.2 + 74.3
Other business activities n.e.c.	74 less 742 + 743	74 less 74.2 + 74.3

1. Only enterprises in the business sector should be included, following the *Frascati Manual*, §§ 163-168. For this NACE/ISIC-group (73), data on the product field should also be collected, following the *Frascati Manual*, § 272.

Countries that use a national industrial classification system rather than ISIC Rev. 3.1 should use concordance tables to convert their industrially classified data to ISIC Rev. 3.1.

247. The **criteria for classification** of statistical units by principal activity should be determined by "the ISIC (NACE) class in which the principal activity, or range of activities, of the unit is included" (UN, 2002, ISIC Rev. 3.1, § 79). The principal activity is the ISIC class that accounts for the majority of the enterprise's value added from its goods and services. If this is not possible, the principal activity can be determined either on the basis of the gross output of the goods sold or services rendered in each ISIC class, by value of sales, or by employment (UN, 2002, ISIC Rev. 3.1, § 80).

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248. The proposed **classification list** is presented in Table 4.1, which contains the basic arrangement of the divisions, groups and classes of ISIC Rev. 3.1/ NACE Rev. 1.1 for the purpose of innovation statistics. The table may be further split, or aggregated, for specific purposes.

4. Classifications by size

249. For innovation surveys, size is the other essential classification of statistical units. Although different variables can be used to define the size of a statistical unit in innovation surveys, **it is recommended that size should be measured on the basis of number of employees**. This recommendation is in line with similar proposals in other manuals in the Frascati family. Given the strata requirements in sample surveys (see Chapter 8), and given that innovation activities other than R&D are widely performed by small and medium-sized units, it is recommended that size classes include smaller firms. In order to maintain international comparability while at the same time allowing flexibility in the number of size classes, **the following size classes are recommended as a minimum**:

Classification of statistical units for innovation surveys by size

Number of employees:

10-49

50-249

250 and above

More detailed breakdowns by size class may also be used, such as a size class for firms with fewer than ten employees. It is important for more detailed size classes to be consistent with the above groups. A proposal would be:

Classification of statistical units for innovation surveys by size – detailed:

0

1-9

10-49

50-99

100-249

250-499

500-999

1 000-4 999

5 000 and above.

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5. Other classifications

5.1. *Type of institution*

250. A further useful classification of statistical units for innovation surveys might be by **type of institution**. This breakdown seems particularly important when the statistical unit is in general the enterprise and in view of the increasing internationalisation of innovation activities. Taking into account these considerations, and similar proposals in the *Frascati Manual* and the *Handbook on Economic Globalisation Indicators*, **it is recommended that when enterprises are the statistical units in innovation surveys they should be classified as follows:**

Classification of statistical units for innovation surveys by type of institution

- Private enterprise:

  a) National (no controlled affiliates[8] (CA) abroad).

  b) Multinational, of which there may be three types:

  - ❖ Foreign-controlled[9] affiliates (CAs) (where the affiliate does not control any other affiliates abroad).
  - ❖ Foreign-controlled affiliates with CAs (parent companies under foreign control).
  - ❖ Parent companies with CAs abroad (parent company not under foreign control).

- Public enterprise (*Frascati Manual*, § 180), "resident non-financial corporations and quasi-corporations that are subject to control by government units, control over a corporation being defined as the ability to determine general corporate policy by choosing appropriate directors, if necessary".

5.2. *Other*

251. Many other types of classifications of statistical units can be used in innovation surveys for analytical purposes. They include:

General enterprise characteristics:

- ***Form of activity,*** with the categories: capital-intensive/labour-intensive/knowledge-intensive.
- ***Type of goods produced,*** with the categories: consumer goods/intermediate goods/investment goods.
- ***Export intensity***, the exports of the enterprise as a ratio of sales revenue/turnover.[10]
- ***Geographic location***.

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Innovation indicators:

- ***Innovation or R&D intensity***, the ratio between innovation expenditure (or R&D expenditure) and turnover.
- ***Co-operation*** with other enterprises/public institutions.

Notes

1. They are not the same if, for example, a questionnaire is sent to an enterprise (reporting unit), but the data are reported individually from each division of the enterprise (observation units).
2. Council Regulation (EEC) No 696/93 of 15 March 1993 on the statistical units for the observation and analysis of the production system in the Community, OJ No L 76, p.1, section III/A of the annex.
3. *i.e.* "…the smallest combination of legal units that is an organisational unit…". ISIC Rev. 3.1 § 49: "In such cases, for statistical purposes it is inappropriate and unnecessary to regard each legal entity as a separate institutional unit."
4. Council Regulation (EEC) No. 696/93 of 15 March 1993, OJ No. L76 of 3 March and ISIC Rev. 3 § 91.
5. The local unit as defined by the EU: "The local unit is an enterprise or part thereof (*e.g.* a workshop, factory, warehouse, office, mine or depot) situated in a geographically identified place. At or from this place economic activity is carried out for which – save for certain exceptions – one or more persons work (even if only part-time) for one and the same enterprise." (Council Regulation [EEC] No. 696/93 of 15 March 1993, OJ No. L76 of 3 March 1993)
6. For a detailed discussion of the problem of the local unit as the statistical unit in innovation surveys see Eurostat (1996), particularly part B.
7. Revisions of the International Standard Industrial Classification (ISIC Rev. 4) and the Statistical Classification of Economic Activities in the European Community (NACE Rev. 2) are expected to be completed in 2007. Industrial classifications should be modified accordingly upon the implementation of these revisions.
8. A controlled affiliate is an enterprise that is directly or indirectly controlled by a parent company. See OECD (2005).
9. Control is defined in OECD (2005) as having more than 50% ownership or control of more than 50% of voting shares.
10. Turnover or sales revenue is the total amount of money that the firm has earned from the sales of all its products during a given time period.

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Chapter 5

Linkages in the Innovation Process

1. Introduction

252. The innovative activities of an enterprise[1] depend in part on the variety and structure of its links to sources of information, knowledge, technologies, practices and human and financial resources. Linkages act as sources of knowledge and technology for an enterprise's innovation activity, ranging from passive sources of information to suppliers of embodied and disembodied knowledge and technology to co-operative partnerships. This chapter makes recommendations on how to measure these linkages, with a focus on links to sources outside the enterprise. Linkages can be related to any of the four types of innovations (*i.e.* product, process, marketing or organisational). This chapter is designed to provide guidelines both for measuring linkages for individual innovation types or subsets of innovation types (such as product and process innovations) and for all innovation types combined.

253. Each linkage connects the innovating enterprise to other actors in the innovation system: government laboratories, universities, policy departments, regulators, competitors, suppliers and customers. Innovation surveys can obtain information on the prevalence and importance of different types of linkages and on the factors that influence the use of specific linkages. Identifying the linkages in innovation activity provides evidence of the complexity of the activity, but stops short of providing the information necessary for a dynamic model, with positive and negative feedback loops and non-linear outcomes resulting from change. However, such information can make a valuable contribution to understanding innovation systems and can help determine the influence of government programmes to encourage greater knowledge sharing or technology diffusion.

254. Linkages may depend on the nature of the enterprise and on its market (Dierkes, 2003). For example, the innovative activities of an enterprise operating in a stable, mature sector will be driven by the value of its turnover and the cost of its inputs. Under these circumstances, the enterprise may focus on incremental innovation and its principal links may be to suppliers and to customers' market signals. In a more volatile environment, the enterprise may need to rapidly introduce new products, seek new markets, and introduce new technologies, production methods and organisational methods. The enterprise may develop multiple linkages to obtain new information, knowledge, technologies, production practices and human and

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financial resources. In all cases, information on linkages shows how the enterprise responds to its business environment.

255. Linkages vary by source (whom or what the link is with), cost (the amount of investment required), and level of interaction (the direction of information flows and the level of interpersonal contact). Some external sources consistently provide information at nominal cost, such as patent disclosures or publications, while others, such as consultants, are usually costly. The level of interaction of a linkage influences the characteristics of the information or knowledge that can be obtained. Less interactive linkages that require no interpersonal contact and are based on one-way information flows, such as reading publications or searching patent databases, can only provide codified information. Conversely, highly interactive linkages involving close working relationships, such as with a supplier, can provide both codified information and tacit knowledge and real-time problem-solving assistance. However, enterprises may avoid some types of highly complex links if they have concerns about the loss of intellectual property.

256. A linkage can be internal to the unit or external, depending on how the unit is defined (see Chapter 4). Even if business units are formally organised as separate enterprises, they may belong to the same enterprise group. Units may be part of multinational enterprises so that within-enterprise links cross national boundaries. Enterprises that belong to marketing chains (for instance clothing) or highly integrated value chains may view linkages with other enterprises in the chain more as internal than external.

257. The inflow of knowledge and technology is one side of what is often referred to as diffusion. Diffusion also involves outflows from the innovating enterprise. *Outbound diffusion* is relevant both for identifying the economic effects of innovation and for establishing the shape of an enterprise's network. As with highly interactive linkages, outbound diffusion is influenced by concern over knowledge leakages and the methods enterprises use to protect their intellectual property.

258. Also related to linkages are questions on the developer of the innovations. These questions establish whether innovations are mainly developed by enterprises themselves or in co-operation with other enterprises or public research institutions, or if innovations are mainly developed outside the enterprise.

259. The benefits of linkages will depend on how well knowledge is shared throughout the enterprise and channelled into the development of new products, processes and other innovations. *Knowledge management* involves practices for gaining external knowledge and interacting with other organisations, and for sharing and utilising knowledge within the enterprise.

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260. Trust, values and norms can have an important impact on the functioning of external relations and on the exchange of knowledge within the enterprise. Given this, building *social capital* may be a vital part of an enterprise's innovation strategies. The term "social capital" has many meanings outside of economic analysis and this can lead to confusion. *Network capital* has been used as an alternative.

261. Three additional topics of relevance to linkages are covered in Chapter 4. Several *factors that hamper* innovation activity involve linkages such as access to information and opportunities for co-operation. The section on the *objectives and effects of innovation* addresses improving the capture and use of knowledge. Firms may use different *methods of protection* to control the flow of knowledge to other firms. These are relevant to some types of highly interactive linkages.

2. Inbound diffusion

262. *Diffusion* is the spread of innovations, through market or non-market channels, from first implementation anywhere in the world to other countries and regions and to other markets and firms. The diffusion process often involves more than the mere adoption of knowledge and technology, as adopting enterprises learn from and build on the new knowledge and technology. Through the diffusion process, innovations may change and supply feedback to the original innovator.

263. Identifying how transfers of knowledge and technology take place, what the main sources of knowledge and technology flows are for enterprises, and which of these are of greatest importance are central to understanding linkages in the innovation process. They result in better understanding of diffusion processes and make it possible to map linkages and knowledge flows, and they are of direct relevance for innovation policy. For example, should policy focus on promoting active co-operation and, if so, which types of partners are most important? Or, are knowledge and technology flows of greater importance when due to networks and other informal arrangements that do not involve active co-operation?

264. This section discusses three types of linkages or flows of knowledge and technology to enterprises: *open information sources* that do not involve purchases of knowledge and technology or interaction with the source; purchases or *acquisition of knowledge and technology*; and *innovation co-operation*.

2.1. Types of linkages

265. *Open information sources* provide access to knowledge without the need to pay for the knowledge itself, although there may be marginal fees for access (membership in trade associations, attendance at conferences, subscriptions

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to journals). Open information sources do not provide access to knowledge embodied in machinery or equipment or the right to use knowledge protected by patents and other forms of intellectual property, although the knowledge behind the patent can be accessed through patent databases. Some open sources, such as attendance at fairs or exhibitions, can give access to some tacit knowledge through personal interaction with other participants.

266. Codified knowledge can take many forms, such as published articles, standards, metrology (methods of measuring items such as liquid or gas flow, time, chemical pollutants, etc.), or knowledge gained from networks, arm's-length contact with suppliers, or trade fairs.

267. Some information, such as feedback from clients or suppliers, may be very easy to use. It may be more difficult, depending on employee capabilities, to use other information, for example from universities. An additional challenge for using information sources is locating them. Enterprises may have limited knowledge about potential information sources. Data on information sources can aid in designing policy initiatives for training, improving ICT capabilities and establishing networks and support services.

268. Knowledge networks facilitate the exchange of technology and commercial information. Informal networks tend to be based on personal contacts or "communities of practice" or simply arise in the normal course of business. Formal or managed networks can be organised by business organisations such as chambers of commerce, research associations, technology services companies, consultants, universities or public research organisations or sponsored by local, regional or central governments.

269. *Acquisition of technology and knowledge* involves the purchase of external knowledge and technology without active co-operation with the source. This external knowledge can be embodied in machinery or equipment that incorporates this knowledge. It can also include the hiring of employees who possess the new knowledge, or the use of contract research and consulting services. Disembodied technology or knowledge also includes other know-how, patents, licences, trademarks and software.

270. Data on sources of acquisitions provide information on flows of knowledge and technology and on where (in terms of regions, industries) these acquisitions are most prevalent. Identifying the importance of purchases of knowledge and technology is also useful in motivating further analysis of how well "trade" in knowledge and technology functions.

271. *Innovation co-operation* involves active participation in joint innovation projects with other organisations. These may either be other enterprises or non-commercial institutions. The partners need not derive immediate commercial benefit from the venture. Pure contracting out of work, where there is no active collaboration, is not regarded as co-operation. Co-operation

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is distinct from open information sources and acquisition of knowledge and technology in that all parties take an active part in the work.

272. Innovation co-operation allows enterprises to access knowledge and technology that they would be unable to utilise on their own. There is also great potential for synergies in co-operation as partners learn from each other.

273. Innovation co-operation can take place along supply chains and involve customers and suppliers in the joint development of new products, processes or other innovations. The level of interaction along supply chains (*i.e.* whether linkages involve co-operation, or arm's-length exchanges of information or purchases of technology) may depend on the type of knowledge and technology. For example, concerning product development, if the technology is non-modular, innovation along the supply chain must be closely co-ordinated because changes in the technological configuration of one part of a product must take account of changes in any of the others. If the technologies involved are completely modular, the assemblers of the final product can deal with suppliers of components, materials, etc., on an arm's-length basis, in which interaction mainly consists of purchases of equipment or services embodied with the new knowledge. Exchange of technological and business information naturally accompanies trade in goods and services. Information on customer needs and their experience of a supplier's products plays a key role in innovation.

274. Innovation co-operation can also involve horizontal collaboration, with enterprises working jointly with other enterprises or public research institutions. Examples are the joint development of new technologies, products or processes by enterprises that sell the same type of product but possess complementary assets, *e.g.* sell in different geographical markets or different market niches. Horizontal co-operation on innovation may also include strategic marketing alliances to develop and implement new marketing concepts. It may take place between enterprises that produce different but highly complementary products, *e.g.* a new computer-controlled machine tool and the software package needed to monitor and control it.

275. While the focus of this chapter is on external linkages, the *internal sourcing of information* is also important. The identification of which parts of the enterprise (*e.g.* R&D, marketing, production, distribution) are important sources of information for innovation activities provides information on the flow of knowledge within the enterprise.

276. The potential sources for the three types of linkages are similar, though some are only relevant as openly available sources of knowledge and technology. Table 5.1 shows sources for all three types of linkages and indicates for which types each source is relevant. It includes internal sources, other enterprises, public and non-profit research institutions, and a number of general information sources. The definition of several sources must be

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Table 5.1. **Sources for transfers of knowledge and technology**

	Open information sources	Sources for purchases of knowledge and technology	Co-operation partners
Internal sources within the enterprise:	*		
R&D	*		
Production	*		
Marketing	*		
Distribution	*		
Other enterprises within the enterprise group	*	*	*
External market and commercial sources:			
Competitors	*	*	*
Other enterprises in the industry	*	*	*
Clients or customers	*		*
Consultants/consultancy firms		*	*
Suppliers of equipment, materials, components, software or services	*	*	*
Commercial laboratories	*	*	*
Public sector sources:			
Universities and other higher education institutions	*	*	*
Government/public research institutes	*	*	*
Private non profit research institutes	*	*	*
Specialised public/semi-public innovation support services	*	*	*
General information sources:			
Patent disclosures	*		
Professional conferences, meetings, branch literature and journals	*		
Fairs and exhibitions	*		
Professional associations, trade unions	*		
Other local associations	*		
Informal contacts or networks	*		
Standards or standardisation agencies	*		
Public regulations (*i.e.* environment, security)	*		

adapted to country-specific terminology to clearly differentiate between commercial laboratories, government research institutes and private non-profit research institutes.

277. Multinational enterprises (MNEs) are a special case. Interactions within the MNE can take place across countries. Given that statistical units for innovation surveys only include the domestic part of MNEs (see Chapter 4), interactions with foreign units of the MNE should be considered as external linkages, with "other enterprises within an enterprise group".

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2.2. Collecting data on linkages in the innovation process

278. **It is recommended that data be collected on all three types of linkages, drawing on the list of sources above**. For use in innovation surveys, these types of linkages can be defined as:

- ***Open information sources:*** *openly available information that does not require the purchase of technology or intellectual property rights, or interaction with the source.*
- ***Acquisition of knowledge and technology:*** *purchases of external knowledge and/or knowledge and technology embodied in capital goods (machinery, equipment, software) and services, which do not involve interaction with the source.*
- ***Innovation co-operation:*** *active co-operation with other enterprises or public research institutions for innovation activities (which may include purchases of knowledge and technology).*

279. Designing questions on types of linkages in innovation surveys presents a number of challenges. While all three types of linkages are of interest, separate questions on each type may result in large response burdens and, given the similarity of the questions, may be very tiresome for enterprises to answer. The paragraphs below discuss a number of relevant aspects and some options for covering these topics in innovation surveys.

280. Linkages can generate knowledge and technology for any of the four types of innovations (*i.e.* product, process, organisational and marketing innovations). A large share of the interactions will involve the development of new products or processes; however linkages may, in many cases, also involve product design, the development of new marketing techniques, or work on organisational innovations such as the integration of enterprises with customers, suppliers or retailers.

281. **Questions on linkages can refer to all innovation types combined, to individual types, or to closely related subsets of the four types, such as product and process innovations.** The ability to identify which type of innovation a linkage primarily relates to (*e.g.* work on individual types of innovations, or a subset of types such as product and process innovations) can aid greatly in interpreting the data. For example, linkages involving the development of a new good or service can differ greatly from linkages involving the development of new marketing methods.

282. **Questions on linkages can use either a binary scale (*i.e.* yes/no) or an ordinal scale and ask enterprises whether they have used the source and, if so, its importance.** An ordinal scale is useful for identifying the most important sources (see the discussion of binary and ordinal scales in Chapter 8). However, use of an ordinal scale may also limit the options for designing questions on linkages.

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283. Some information on acquisition of knowledge and technology can be obtained from questions on innovation activities (see Chapter 6), although these questions do not ask about the source of the purchase.

284. **In order to detect and better understand the process of clustering or networking in the field of innovation, additional information can be obtained by asking for the geographical location of co-operation partners (local, national, foreign by region or country).** Information on the geographic location of sources (domestic or foreign) may also be useful for open information sources and acquisition of knowledge and technology.

285. To better interpret results on linkages, questions can be asked about the enterprise's status as part of an enterprise group and its position in a value chain.

2.2.1. Options for designing linkage questions for innovation surveys

286. Types of linkages, reference to types of innovation, use of binary or ordinal scales and the geographical location of linkages have been identified as four main factors that innovation surveys can take into consideration in designing questions on linkages. In order to provide some additional guidance, three options are outlined below.

287. One option when designing linkage questions for innovation surveys is to include a combined question that asks whether sources are relevant as information sources, as sources of purchases of knowledge and technology, or as co-operation partners. This allows for including all three types of linkages and eliminates repetition. For this option, it is only feasible to utilise a binary (yes/no) scale. The question could refer either to product and process innovation or to all innovation types. However, restricting the question to product and process innovation (as opposed to all innovation types combined) would aid when interpreting the data. Supplementary questions could ask whether enterprises have had linkages (*e.g.* co-operative partners or information sources without specifying the specific types) for each type of innovation. A further question might ask about the geographic location of the enterprise's linkages.

288. A second option, which has been used in a number of innovation surveys, is to include two separate questions on linkages, one on information sources and their relative importance, and one on co-operation partners, their relative importance and their location. In using this option, it is important to distinguish between information sources and co-operation partners (*e.g.* if no guidelines are given, any co-operation partner will also be considered an open information source). Advantages of this approach include the possibility of asking about the relative importance of each source and the geographic location of co-operation partners. Drawbacks include the fact that acquisition

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of knowledge and technology is not covered (aside from the information gained from questions on innovation activity) and the great deal of repetition in the two questions. As with the above option, these questions might refer either to product and process innovation or to all innovation types, and the same supplementary questions could be asked.

289. A third option would be to include two separate questions on linkages, one on information sources and one on co-operation partners, as above. However, instead of asking about the relative importance of linkages, the questions could ask (using a binary scale) which types of innovation(s) (*i.e.* product, process, organisational, marketing) each linkage involves. The main advantage of this option is that it allows for more detailed information on the type of innovation concerned by each linkage.

2.2.2. Developer of the innovation

290. Additional information can be obtained on diffusion by collecting data on the developer of the enterprise's innovations. Such questions have been included in a number of surveys and can give an indication of how active the enterprise has been in developing its innovations, whether it interacted with other enterprises in their development, or whether the development of the innovation was primarily conducted outside the enterprise.

291. The information provided is different from that obtained from questions on the degree of novelty (see Chapter 3), as enterprises may be developing innovations that already have been implemented by other enterprises. It thus indicates how innovative enterprises are, though not necessarily how novel their innovations are.

292. **It is recommended to ask questions on the developer of enterprises' innovations**. Enterprises can, for example, be asked for each type of innovation whether:

- The innovations were mainly developed by the enterprise itself.
- The innovations were developed by the enterprise in co-operation with other enterprises or institutions.
- The innovations were mainly developed by other enterprises or institutions.

The last two categories can also be broken down into subcategories, for example by distinguishing between innovations developed in co-operation with other firms and in co-operation with public research institutions, or whether other enterprises are part of the same multinational enterprise or enterprise group. As with questions on degree of novelty, questions on the developer of the innovations can be asked for all four types of innovations or for a subset.

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2.3. Other linkage indicators

293. This subsection discusses options for collecting additional data on linkages that are primarily relevant for specialised surveys.

2.3.1. Types of knowledge and methods of transfer

294. In addition to identifying types of linkages and their sources, it may be useful to collect more detailed information on important characteristics of linkages, such as the kinds of knowledge transferred and the method of transfer. Questions of this type are likely to require a specialised survey that may be possible to link to the results of general innovation surveys. Alternatively, supplementary questions can be included in general innovation surveys, for example on the most important external linkage.[2]

295. Questions on the kinds of knowledge that are obtained through a linkage can ask if the knowledge was embodied or disembodied, tacit or codified, public or private, whether it is R&D-based, specific or generic, and what its degree of novelty is. Questions on how the actual transfer takes place can ask about the use of written reports, blueprints, purchases of machinery, components and software, informal contacts, working together, training and presentations.

2.3.2. Social or network capital

296. Social or network capital refers to enterprises' stocks of social trust, values and norms. These have important impacts on the circulation of information within an enterprise and on sharing knowledge in collaborative activities with other organisations. Enterprises may implement new organisational structures or new practices to introduce a new business culture, norms and values, with the objective of improving the enterprise's capacity to innovate. The establishment of trust is also a key factor in maintaining and improving relationships, both within and outside the enterprise. Long-term relationships that can build up mutual trust will likely be beneficial for all participants.

297. Information can be gained on enterprises' activities to improve social capital through questions on organisational innovation, *e.g.* if enterprises have implemented new practices and routines to introduce a new business culture and values. Additional information can be gained from specialised surveys. For example, questions on the duration of an external linkage can provide an indicator of the level of trust in the relationship. An option is to include questions on the date of establishment of partnerships or strategic alliances, for example within the last five years, more than five years ago, etc. Questions on the degree of formalisation of a relationship, such as on the use of formal contracts, add information on the social and cultural values involved

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and on the degree of trust. Further details on the role of trust can be gained by asking how the partner was identified, such as through prior knowledge, recommendations, or at arm's length through means such as advertising.

2.3.3 Additional information on innovation co-operation

298. Additional information can be collected about the formalities regulating co-operation, specific knowledge delivered in the field of the co-operation agreement, and more general economic information (such as sector, size and age) about each partner.

299. An additional option is to ask for the number of different partners for each category. This would make it possible to distinguish between large and small networkers. The number and duration of relationships are also of interest. Ideally this could contribute to distinguishing the importance of the different relationships that make up the networks surrounding the firms.

3. Outbound diffusion

300. The value of innovations goes far beyond the impact on the developing firm itself. It is therefore of interest to examine the effects and benefits of innovations for other firms, consumers and the general public. Outbound diffusion can take place via the sale of a new good or service to consumers or the sale of a new product or process to another firm. However, outbound diffusion is much broader than this, and can also include the sharing of information and the diffusion of organisational and marketing innovations. Parts of this process have been discussed in connection with collaboration, which by definition involves active participation – and knowledge or technology transfer – for all partners.

301. While it may be difficult for enterprises to assess the impact of their innovations outside of their own enterprise or to track the use of any kinds of new knowledge, it may be possible to gain information on the *users* of a firm's innovations. This may be addressed by identifying the main users of their innovations for the following classifications:

- Consumer markets:
  - ❖ Domestic.
  - ❖ Foreign.
- Inputs to other firms:
  - ❖ Domestic (*inside/outside group*).
  - ❖ Foreign (*inside/outside group*).

This information may also be useful for identifying the structure of demand for the firm's innovations. The innovative activities, strategies and problems of firms that sell to intermediate users such as other firms may differ from those of firms that sell to final consumers.

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4. Knowledge management

302. Knowledge about the core processes, products and markets can be considered to be what constitutes a firm. Decisions on how to use and exchange existing knowledge and obtain new knowledge are essential to the operation of enterprises. Proper systems for managing knowledge can therefore improve competitiveness and innovative ability.

303. Knowledge management involves activities relating to the capture, use and sharing of knowledge by the organisation. It involves the management both of external linkages and of knowledge flows within the enterprise, including methods and procedures for seeking external knowledge and for establishing closer relationships with other enterprises (suppliers, competitors), customers or research institutions. In addition to practices for gaining new knowledge, knowledge management involves methods for sharing and using knowledge, including establishing value systems for sharing knowledge and practices for codifying routines.

304. Examples of knowledge management practices aimed at improving the internal flow and use of information are:

- Databases of worker "best practices".
- Regular education or training programmes.
- Informal and formal work teams that promote worker communication and interaction.
- Integration of activities, which promotes interaction among employees from different areas, for example engineers and production workers.

305. A number of surveys on knowledge management practices have been conducted in recent years, most notably in Canada (see Foray and Gault, 2003; Earl, 2003) in conjunction with the OECD and international experts. This survey covered a number of aspects of knowledge management practices, such as policies and strategies, leadership, knowledge capture, training and communications, and reasons for use of knowledge management practices and the sources that prompted the development of these practices. In addition, questions on knowledge management have been included in innovation surveys.[3] Both approaches have had some success in gaining information on knowledge management practices.

306. As discussed in Chapter 3, organisational innovations may involve the implementation of significant changes in practices for knowledge management, and some information on knowledge management can be gained from questions on organisational innovation. However, detailed examinations of knowledge management activities require specialised surveys. This information can then be linked with information from general innovation surveys.

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Notes

1. Throughout the remainder of the Manual, the use of the term enterprise should be understood as referring to the primary statistical unit.
2. See for example, the DISKO-surveys on innovation in Denmark and Norway, and OECD (2001).
3. For example, the CIS3 survey in France, the J-NIS 2003 survey in Japan, and the Australian Innovation Survey 2003.

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Chapter 6

Measuring Innovation Activities

1. Introduction

307. Information on innovation activity is useful for a number of reasons. It can provide information on the types of innovation activity enterprises engage in, for example: whether innovative enterprises engage in R&D; whether they purchase knowledge and technology in the form of extramural R&D, machinery and equipment, or other external knowledge; whether the development and implementation of innovations also involves the training of employees; and whether enterprises are engaged in activities to change part of their organisation.

308. Innovation activities, including capital purchases, R&D and other current expenditures related to innovations, can be characterised as investments in that they may yield returns in the future. Such returns often go beyond the specific innovation the activity is directed towards. For example, investments in R&D and innovation-related training are often open-ended in nature, allowing their application to other tasks.

309. Quantitative measures of expenditures on each innovation activity provide an important measure of the level of innovation activity at enterprise, industry and national levels. These measures may also be used, along with output measures, to calculate returns to innovation activities.

310. As the *Frascati Manual* states, R&D is only one step in the innovation process. Innovation involves a number of activities not included in R&D, such as later phases of development for preproduction, production and distribution, development activities with a lesser degree of novelty, support activities such as training and market preparation for product innovations, and development and implementation activities for new marketing methods or new organisational methods. In addition, many firms may have innovation activities that do not involve any R&D.

311. In addition to innovation activities, a number of other factors may affect the ability to absorb new knowledge and technology and to innovate. Among them are firms' knowledge bases, workers' abilities and academic backgrounds, the implementation of ICTs, and proximity to public research institutions and regions with a high density of innovative firms. Identifying the main factors that allow firms to innovate and the factors that enhance their ability to innovate is of great importance for policy.

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312. As outlined in Chapter 2, innovation is a complex process, and the scale of activity required for innovation may vary considerably. For example, the in-house development of a radically different and sophisticated electronic product for the mass market will involve many more steps than the introduction of an improved process resulting from technology incorporated in a pre-programmed machine purchased for the purpose.

313. Innovation activities may be carried out within the firm or may involve the acquisition of goods, services or knowledge from outside sources, including consulting services. A firm may acquire external knowledge and technology in disembodied or embodied form.

2. The components and coverage of innovation activities

314. As defined in Chapter 3, innovation activities are all those scientific, technological, organisational, financial and commercial steps, including investment in new knowledge, which actually lead to, or are intended to lead to, the implementation of innovations. These activities may either be innovative in themselves, or required for the implementation of innovations. Also included are basic research activities that (by definition) are not directly related to the development of a specific innovation.

315. In order to enable comparability with the results of innovation surveys based on the second edition of the *Oslo Manual*, all innovation activities other than R&D are divided between product and process innovation activities on the one hand, and marketing and organisational innovations on the other.

316. In order both to maintain continuity with earlier measures of product and process innovation activities and to expand coverage to include activities related to all types of innovations, the following conventions are adopted:

- While most R&D is related to product and process innovations, some may be related to marketing or organisational innovations. Basic research is by definition not related to any specific innovation. All R&D is included as innovation activity. Furthermore, R&D is defined as a separate category that includes relevant activities for product, process, marketing and organisational innovations, along with basic research.
- All innovation activities other than R&D that are specifically related to marketing and organisational innovations and not related to a product or process innovation are included under the categories *preparation for marketing innovations* and *preparation for organisational innovations,* respectively. This includes acquisition of other external knowledge or capital goods and training that is specifically related to marketing or organisational innovations.

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2.1. Research and experimental development

317. *Research and experimental development (R&D) comprises creative work undertaken on a systematic basis in order to increase the stock of knowledge, including knowledge of man, culture and society, and the use of this stock of knowledge to devise new applications* (as defined in the *Frascati Manual*).

318. All R&D activities financed or performed by enterprises are included as innovation activities. This includes total intramural and extramural R&D as defined in the *Frascati Manual*. It is also worth emphasising the importance of using the definition and guidelines for R&D of the *Frascati Manual* when collecting data on R&D in innovation surveys. Therefore, surveys should state that the definition of R&D is the same as that used in R&D surveys. This will aid comparison with R&D surveys and facilitate the use of the R&D data separately.

319. Software development is classified as R&D if it involves making a scientific or technological advance and/or resolving scientific/technological uncertainty on a systematic basis. Services development is classified as R&D if it results in new knowledge or involves the use of new knowledge to devise new applications.

320. Construction and testing of a prototype is classified as R&D if the primary objective is to make further improvements. This is often the most important phase of the experimental development of an innovation. A prototype is an original model (or test situation) that includes all the technical characteristics and performances of the new product or process. Acceptance of a prototype often means that the experimental development phase ends and the next phase of the innovation process begin (further guidance may be found below and in the *Frascati Manual*).

321. Intramural R&D comprises all R&D performed within the enterprise as defined in the *Frascati Manual* and as reported in R&D surveys. It includes both R&D intended to contribute to the development and implementation of product, process, marketing or organisational innovations and basic research that is not directly related to the development of a specific innovation. Note that, following the *Frascati* definition, intramural R&D also includes the acquisition of capital goods that is directly related to R&D.

322. Extramural R&D comprises the acquisition of R&D services. It also includes the acquisition of R&D services from units of multinational enterprises (MNEs) located abroad.[1]

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2.2. Activities for product and process innovations

2.2.1. Acquisition of other external knowledge

323. In addition to R&D, enterprises may acquire technology and know-how in a number of forms and from a variety of sources in connection with the development and implementation of innovations. This also includes acquisitions from foreign units of MNEs.

324. Acquisition of external knowledge and technology may be in the form of patents, non-patented inventions, licences, disclosures of know-how, trademarks, designs and patterns.

325. Acquisition of external knowledge may also include computer services and other scientific and technical services for product and process innovation activities.

2.2.2. Acquisition of machinery, equipment and other capital goods

326. Innovation activities also involve the acquisition of capital goods, both those with improved technological performance and those with no improvement in technological performance that are required for the implementation of new or improved products or processes. This category only includes the acquisition of capital goods for innovation that is not included in R&D activities. Note that this category also includes acquisition of capital goods from foreign units of MNEs (which is not included in R&D).

327. Capital goods for innovations are composed of acquisition of *land and buildings,* of *machinery, instruments and equipment* and, in line with the revised System of National Accounts – SNA, of *computer software*, which is a component of intangible investment and considered as capital formation.[2]

328. *Land and buildings* includes the acquisition of land and buildings for product and process innovation activities including major improvements, modifications and repairs.

329. *Machinery, instruments and equipment* includes major instruments and equipment acquired for use in product and process innovation activities of the firm.

330. *Computer software*, in line with the revised SNA, includes computer software, programme descriptions and supporting materials for both systems and applications software for use in product and process innovation activities of the firm. The acquisition, development or extension of computer databases expected to be used for more than one year in product and process innovation activities of the firm are also included.

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2.2.3. Other preparations for product and process innovations

331. Enterprises' development of innovations may include a number of in-house activities that are not included in R&D as defined by the *Frascati Manual*. They include both the later phases of development activities and, importantly, the introduction of product and process innovations that are new to the firm, but not new to the market (or, in terms of the definition of R&D, do not increase the stock of knowledge or contain an appreciable element of novelty). Development and implementation activities for the adoption of new goods, services and processes may represent an important share of innovation activity.

332. *Other preparations for product and process innovations* includes internal activities involved in the development and implementation of product and process innovations that are not included in R&D. They include development activities that are either partially excluded as R&D (such as industrial design, engineering and set-up, and trial production) or fully excluded (such as patent and licence work, production start-up and testing), and development activities for product or process innovations that do not meet the novelty requirement for R&D (*i.e.* they are new to the firm but not new to the market). Some of the elements of this category are described in greater detail below.

333. *Other development activities for services* include internal activities involved in the planning and development of new or significantly improved services that are not included in R&D (see also *Frascati Manual*, §§ 145-151).

334. Design can include a wide range of activities aimed at planning and designing procedures, technical specifications and other user and functional characteristics for new products and processes. Among them are initial preparations for the planning of new products or processes, and work on their design and implementation, including adjustments and further changes. Also included is *industrial design*, as defined in the *Frascati Manual*, which involves the planning of technical specifications for new products and processes. Some elements of industrial design should be included as R&D (see *Frascati Manual,* §§ 124-125) if they are required for R&D.

335. *Testing and evaluation* comprise the testing of new or significantly improved products or processes, while testing of prototypes is part of R&D, and so is excluded here. For manufacturing, trial production and pilot plants are included if they are not already included in R&D. Trial production is included in R&D if production implies full-scale testing and subsequent further design and engineering, while pilot plants are included in R&D if the primary purpose is R&D. Also included here are trials and testing activities for the provision of services, such as tests of how the provision of services functions with the use of new technologies or trials to examine the performance of significant improvements in existing services.

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336. *Setup and engineering* concern changes in production and quality control procedures, methods, standards and associated software required to produce the new or improved product or to use the new or improved process. Also included are changes in procedures and software required for providing new services or the use of new delivery methods.

2.2.4. Market preparation for product innovations

337. *Market preparation for product innovations* can include preliminary market research, market tests and launch advertising for new or significantly improved goods and services.

2.2.5. Training

338. *Training* is a product or process innovation activity when it is required for implementing a product or process innovation, for example so that production workers are able to identify the desired consistency of a new type of yoghurt in a food factory, so that a marketing manager understands the characteristics of an improved braking system on a new model of car in order to prepare the market launch, or so that staff are able to use different Linux programmes after the introduction of a Linux-based PC network in the firm. This category should exclude training that is already included in R&D.

339. Training is not a product or process innovation activity when it is not oriented towards a specific product or process innovation in the firm. For example, the following are not innovation activities: training in existing production methods for new employees, general upgrading training for individuals (supervisors, managers, etc.), ongoing computer training, and language classes. Training for the first-time introduction of new marketing methods or new organisational methods is part of activities for marketing and organisational innovations.

2.3. Activities for marketing and organisational innovations

2.3.1. Preparations for marketing innovations

340. Preparation for marketing innovations comprises activities related to the development and implementation of new marketing methods not previously used by the firm. It includes development and planning of new marketing methods and work involved in their implementation. Activities related to marketing innovations include only those for developing and implementing new marketing methods, not expenditures for using these methods in daily business (such as expenditures to run advertisements, event marketing or sponsoring in the course of a newly introduced marketing method). Note that this category also includes acquisition of other external

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knowledge and of machinery, equipment and other capital goods and training activities that are specifically related to marketing innovations.

341. Preparations for marketing innovations may be related to the development and implementation of the four types of marketing instruments typically distinguished in the business world: preparation for the introduction of new marketing methods in product design or packaging, in pricing methods, in product placement and in product promotion.

2.3.2. Preparations for organisational innovations

342. Preparation for organisational innovations includes the development and planning of new organisational methods and the work involved in their implementation. Note that this category also includes acquisition of other external knowledge and of machinery, equipment and other capital goods and training activities that are specifically related to organisational innovations.

343. Preparation for organisational innovations may be distinguished by new methods in business practices, in workplace organisation and in organisation of external relations.

2.4. Design

344. The term *product design*, as used in the definition of marketing innovations, refers to the form and appearance of products and not their technical specifications or other user or functional characteristics. However, design activities may be understood by enterprises in more general terms, as an integral part of the development and implementation of product or process innovations, as described in Section 2.2.3 of this chapter. The categorisation of design activities will thus depend on the type of innovation they are related to.

345. All design activities for the development and implementation of product innovations (including work on form and appearance) and of process innovations should be included either in *R&D* or in *other preparations for product and process innovations*.

346. Work related to changes in product design that are marketing innovations (and not product innovations, *i.e.* where the functional characteristics or intended uses of the product in question are not significantly improved) should be included in *Preparations for marketing innovations*.

2.5. The borderline between R&D and non-R&D innovation activities

347. Enterprises may have difficulty differentiating between R&D expenditure and other innovation activities, especially at the borderline between R&D and non-R&D activity. Care must be taken to exclude from R&D any activities that are part of the innovation process but rarely involve any

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R&D *(e.g. patent work, licensing, market research, manufacturing start-up, process re-engineering, tooling up)*. At the same time, some activities are at least partly counted as R&D *(e.g. pilot plants, prototypes, industrial design, process development)*.

348. Distinguishing R&D and other innovation activities is particularly difficult for services (see *Frascati Manual,* §§ 145-151), owing in part to the fact that innovation activities in services tend to be less formally organised, and that R&D is less well defined for services than for manufacturing.

349. The basic criteria for distinguishing R&D activities from non-R&D innovation activities are "the presence in R&D of an appreciable element of novelty and the resolution of scientific and/or technological uncertainty" or that they "result in new knowledge or use of knowledge to devise new applications" (see *Frascati Manual*, § 84 and § 146). These criteria imply "that a particular project may be R&D if undertaken for one reason, but not if carried out for another" (*Frascati Manual,* § 85). It is recommended that the guidelines in the *Frascati Manual*, §§ 110-130 and §§ 145-151, should be applied to innovation surveys.

2.6. The development and use of software in innovation activities

350. The development, acquisition, adaptation and use of software pervade innovation activities. Developing new or substantially improved software, either as a commercial product or for use as an in-house process (an innovation in its own right), involves research and experimental development and a range of post-R&D activities. In addition, all types of innovations may involve the acquisition and adaptation of software; the software is not an innovation in itself but is required for the development and implementation of innovations.

3. Collecting data on innovation activities

351. **Summarising the section above, innovation activities can be broken down as follows:**

Research and experimental development

Intramural (in-house) R&D: Creative work undertaken on a systematic basis within the enterprise in order to increase the stock of knowledge and use it to devise new applications. This comprises all R&D conducted by the enterprise, including basic research.

Acquisition of extramural R&D: Same activities as intramural R&D, but purchased from public or private research organisations or from other enterprises (including other enterprises within the group).

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Activities for product and process innovations

Acquisition of other external knowledge: Acquisition of rights to use patents and non-patented inventions, trademarks, know-how and other types of knowledge from other enterprises and institutions such as universities and government research institutions, other than R&D.

Acquisition of machinery, equipment and other capital goods: Acquisition of advanced machinery, equipment, computer hardware or software, and land and buildings (including major improvements, modifications and repairs), that are required to implement product or process innovations. Acquisition of capital goods that is included in intramural R&D activities is excluded.

Other preparations for product and process innovations*:* Other activities related to the development and implementation of product and process innovations, such as design, planning and testing for new products (goods and services), production processes, and delivery methods that are **not** already included in R&D.

Market preparations for product innovations: Activities aimed at the market introduction of new or significantly improved goods or services.

Training: Training (including external training) linked to the development of product or process innovations and their implementation.

Activities for marketing and organisational innovations

- ***Preparations for marketing innovations:*** Activities related to the development and implementation of new marketing methods. Includes acquisition of other external knowledge and other capital goods that is specifically related to marketing innovations.
- ***Preparations for organisational innovations:*** Activities undertaken for the planning and implementation of new organisation methods. Includes acquisition of other external knowledge and other capital goods that is specifically related to organisational innovations.

352. Total expenditure for innovation activities comprises current and capital expenditure incurred for the innovation activities defined above. Current innovation expenditures are composed of labour costs and other current costs. Capital expenditures for innovations are composed of gross expenditures on land and buildings, on instruments and equipment and on computer software. Capital expenditures that are part of R&D are included in *intramural R&D*, while non-R&D capital expenditures linked to product and process innovations are included in *acquisition of machinery, equipment and other capital goods*. Non-R&D capital expenditures specifically linked to marketing or organisational innovations are included in *preparations for marketing innovations* and *preparations for organisational innovations*, respectively. The remaining categories of innovation activity consist solely of current expenditure.

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353. Innovation surveys can collect both qualitative and quantitative data on innovation activities. Qualitative data involves questions on whether or not enterprises have engaged in an innovation activity. Quantitative data involve questions on expenditures for an innovation activity.

354. Innovation expenditure data are among the most important and are in demand both for research and policy. However, innovation expenditure questions are also among the most difficult and time-consuming to answer. Innovation surveys may consider limiting the number of categories of innovation activities for quantitative questions.

355. Difficulty in reporting innovation expenditure raises two issues that innovation surveys may consider when designing quantitative questions on innovation activities. The first is the response burden. While activities such as R&D may be confined to one department, innovation activity may take place throughout the enterprise. In addition, expenditures on a number of activities may not be directly available from enterprises' accounting systems. Expenditure questions are thus likely to be the most time-consuming to answer, and detailed questions on expenditure may therefore have an impact on unit and item response rates. This is of particular concern for non-mandatory surveys.

356. A second, related issue is the quality of the data. Data quality is likely to be best for expenditures that can be extracted from accounting information; other expenditures may be rough estimates, if given at all. Questionnaire design, the number of expenditure categories and wording may be very important for the quality of the data collected on innovation expenditure.

3.1. Qualitative data on innovation activity

357. **It is recommended that qualitative data be collected on innovation activities. Questions on whether or not firms have engaged in the above activities can either refer to a single year or the entire observation period.** Surveys may wish to collect qualitative data on all categories of innovation activities or on a subset of these. The multi-year approach has the advantage of capturing innovation activity for enterprises that may not perform innovation activity on a regular basis.

358. Additional information can also be collected on individual types of innovation activities. Examples are whether R&D activity is continuous or occasional, which types of external knowledge the enterprise has acquired, or a separate question on software expenditures.

3.1.1. Other qualitative indicators of innovation activity

359. Information on employee characteristics, such as the level of education and number of technical staff, can also be collected in innovation surveys. For

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example, the share of employees with a higher education certificate or degree (ISCED 5-6) and the share of personnel involved in innovation or R&D activity can be used as supplementary measures of the innovation capability of the firm's knowledge stock and employees. Furthermore, most enterprises are likely to possess information on their employees' level of education. An additional qualitative indicator is whether enterprises participate in national or supranational programmes that provide financial support for employee education/training or for the employment of research personnel.

3.2. Quantitative data on innovation activity

360. **For the collection of quantitative data on innovation expenditures, it is recommended that a breakdown by type of activity should be used** (see Section 3 of this chapter). Surveys may wish to collect quantitative data on all categories of innovation activities or, as innovation expenditures are difficult to measure, surveys may opt to collect data on a subset of these.

361. Innovation expenditure can also be broken down by type of expenditure (current innovation expenditure vs. capital expenditures for innovations) and by source of funds. These are discussed in Sections 3.4 and 3.5.

362. While collecting data on innovation activities for a multi-year period may be feasible for qualitative questions on innovation activities, restricted availability of data within firms is a serious obstacle to the multi-year approach for quantitative data. Therefore, it is **recommended that quantitative questions on innovation expenditure refer only to the last year of the observation period, the reference year.**

363. **Concerning capital purchases, expenditures for the category, *acquisition of machinery, equipment and other capital goods*, should exclude purchases of capital goods that are already included in *intramural R&D*.** Purchases of capital goods should be included in full for the period in which they took place. All depreciation provisions for building, plant and equipment, whether real or imputed, should be excluded from the measurement of intramural expenditure.

364. Enterprises often face severe problems for supplying reliable estimates of capital expenditure for innovation activities. To assist them, data on *total capital expenditure* (including capital expenditure not related to innovation activities) can be collected as well. This will help in checking the reliability of innovation expenditure data.

365. Some innovations span more than one type of innovation. An example is the implementation of a marketing innovation that is connected to a product innovation. **In order to avoid double counting, innovation surveys**

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should ensure that innovation expenditures are included in no more than one category of innovation activities.

3.3. Other measurement issues

3.3.1. Intramural and extramural expenditure

366. While most innovation activities are separated according to intramural and extramural expenditures, full separation may not be feasible for most enterprises and is not recommended.

367. The inclusion of extramural expenditures is important at the micro level for measuring expenditures for individual enterprises. However, **special care must be taken when aggregating individual enterprise amounts to industry or national figures, because of double counting.** Double counting is most likely to occur for extramural R&D and acquisition of other external knowledge.

3.4. Breakdown by type of expenditure

368. Expenditure for innovation activities may also be broken down into current and capital expenditure. This can be useful if the data are to be compared with those on intangible investment, with which innovation expenditure is sometimes confused (see Section 3.4.1 below). Among the categories of innovation activities, capital expenditures for innovation are included in *intramural R&D*, *acquisition of machinery, equipment and other capital goods,* and potentially also in *preparations for marketing innovations* and *preparation for organisational innovations*. All other categories consist solely of current expenditures. Thus, it may be possible to obtain a breakdown of innovation expenditure by type of expenditure by asking enterprises to specify *R&D*, *preparations for marketing innovations* and *preparations for organisational innovations* according to current and capital expenditures. However, given that this would increase response burdens and that R&D expenditure is collected in considerable detail through other surveys in most countries, this breakdown is not recommended for general innovation surveys.

369. **Current innovation expenditures** are composed of *labour costs* and *other current costs:*

- ***Labour costs*** comprise annual wages and salaries and all associated costs of fringe benefits such as bonus payments, holiday pay, contributions to pension funds and other social security payments and payroll taxes. The labour costs of persons not involved in innovation activities (such as security personnel and maintenance staff) should be excluded here and included under other current costs.

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- ***Other current costs*** comprise non-capital purchases of materials, supplies, services and equipment to support innovation activities performed by the firm in a given year.

370. **Capital expenditures for innovations** are defined above.

3.4.1. The relation between intangible investment and innovation expenditure

371. *Intangible investment* covers all non-capital expenditure for the firm's development which is expected to give a return over a longer period than the year in which it is incurred. It is generally taken to cover expenditure on non-routine marketing, training, software and some other similar items, in addition to current expenditure on R&D.

372. *Current expenditure on innovation* is clearly a part of intangible investment, but intangible investment comprises elements which are not part of current innovation expenditure. For example, only training in connection with the introduction of innovations is classified as innovation expenditure, whereas intangible investment includes all of the firm's training expenditure. Marketing in connection with the introduction of new products or the development and implementation of new marketing methods is classified as innovation expenditure. Intangible investment, on the other hand, includes all marketing expenditure in general.

373. At the same time, innovation expenditure includes tangible investment such as capital expenditure on R&D, and the acquisition of new machinery and equipment related to innovations.

3.5. Breakdown by source of funds

374. It is important to know how innovation expenditure is financed, for instance in order to evaluate the role of public policy and internationalisation in the innovation process. The following classification by **source of funds** can be used:

- Own funds.
- Funds from related companies (subsidiary or associated companies).
- Funds from other (non-financial) enterprises.
- Funds from financial companies (bank loans, venture capital, etc.).
- Funds from government (loans, grants, etc.).
- Funds from supranational and international organisations (EU, etc.).
- Other sources.

In addition, external sources of funds can be broken down into domestic and international sources of funds.

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375. Where survey designers wish to cover these topics, it may be enough, for a variety of policy and research issues, to collect information on whether or not each source is used, instead of seeking an estimate, probably imprecise, of the amount (either in monetary or percentage terms) contributed by each source. This will considerably reduce the response burden on firms, and hence increase the total survey response rate and cut item non-response to this question. Owing to concerns regarding response burdens for general innovations surveys, the Manual makes no recommendation on the extent of coverage of sources of funds.

376. To evaluate the role of government procurement in innovation processes, it is useful to know whether or not a firm participates in government procurement of innovative products and processes at regional, national or international levels.

3.6. *The subject approach versus the object approach*

377. Survey questions on innovation expenditure may be formulated in two ways:

- Total expenditure on innovation activities for the firm in a given year or period (= **the subject approach**).
- Total expenditure for specific innovations implemented in a given year or during a given period regardless of the year in which the expenditure occurs (= **the object approach**).

378. There is a fundamental difference between the two approaches and they lead to different results. Since both have been used in innovation surveys, it seems worthwhile to clarify the relation between them.

379. The **subject approach** covers expenditure for implemented, potential and abandoned innovation activities as defined above. In this respect, it is a straightforward extension of traditional R&D measurement.

380. In the **object approach** the sum reported comprises total expenditure on defined innovations, or on the main innovation(s), implemented during a given period. It excludes expenditure on innovation projects that have been abandoned or are in progress, and on general R&D not connected to a specific application. This approach seems particularly suitable for innovation surveys starting from a set of identified innovations, but it could also be used in surveys of the innovation activities of enterprises in general.

381. In light of the advantages and disadvantages of both approaches, **the subject approach is recommended for reporting on innovation expenditure.** The Manual's guidelines are therefore oriented to the subject approach.

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Notes

1. Foreign units of MNEs are considered as separate statistical units for innovation surveys. See Chapter 4.
2. It is foreseen that the current revision of the 1993 SNA will change the treatment of R&D expenditure from consumption to capital formation.

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Chapter 7

Objectives, Obstacles and Outcomes of Innovation

1. Introduction

382. This chapter discusses incentives for and obstacles to engaging in innovation activity and the impact of innovation. Identifying the factors that drive innovation and those that hinder it is of great value for understanding the innovation process and for formulating innovation policy. Interest in measuring innovation is due to its relation to the performance of enterprises, industries and the economy as a whole. Measures of the impact of innovation on enterprise performance are thus among the most important innovation indicators, but they are also among the most difficult to obtain.

383. The impact of innovations on enterprise performance range from effects on turnover and market share to changes in productivity and efficiency. Among the significant impacts at industry and national levels are changes in international competitiveness and in total factor productivity, knowledge spillovers of firm-level innovations, and an increase in the amount of knowledge flowing through networks.

384. Objectives and barriers vary by type of innovation. For example, the objectives of product or marketing innovations will primarily relate to demand (*e.g.* improving product quality, increasing market share, entering new markets), while process or organisational innovations will tend to relate to supply (*e.g.* reducing costs, improving production capabilities). Some barriers relate to all types of innovation (*e.g.* cost factors) while others relate to a subset of innovation types.

385. This chapter describes a number of indicators for innovation surveys and discusses other measures which, while relevant, may be difficult to include in general innovation surveys but may be included in specialised surveys. Surveys can choose to address questions on objectives, barriers and other indicators to all types of innovations, to subsets such as product and process innovations, or to individual types of innovation. This chapter is designed to provide guidelines for all these approaches.

2. Objectives and effects of innovations

386. Enterprises may engage in innovation activity for a number of reasons. Their *objectives* may relate to products, markets, efficiency, quality or the ability to learn and to implement changes. Identifying enterprises' motives for innovating and their importance is helpful when examining the forces that

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drive innovation activity, such as competition and opportunities for entering new markets. Data on objectives can also provide additional information on the characteristics of types of innovations.

387. Enterprises may or may not succeed in achieving their objectives by implementing innovations, or innovations may have other or additional effects than those that initially motivated their implementation. While *objectives* concern enterprises' motives for innovating, *effects* concern the actual observed outcomes of innovations. The same factors may play a role in both objectives and effects of innovation, although they will be interpreted differently. Table 7.1 lists factors that are relevant to objectives and effects for all four types of innovations. A number of the factors may be relevant for more than one type of innovation. In particular, product and marketing innovations or process and organisational innovations may have a number of factors in common.

388. The factors listed aim to shed light on a number of forces driving enterprises' innovation activity. *Competition, demand and markets* concern the main incentives for product innovations and in some cases for marketing innovations. The intent of questions on these factors is to determine the importance of the motives for product innovations, such as: short product life spans that necessitate the development of new products; the need to diversify product portfolios; or efforts to increase or avoid a decline in market share.

389. In addition, a number of factors aim to identify the main motives for changes in *production and delivery*, *i.e.* whether their main intent is to improve quality, flexibility or efficiency/cost reduction. In particular, factors relating to cost reduction are made specific to enable better interpretation of results. Factors concerning *workplace organisation* identify the main forces behind organisational change: whether they are oriented towards customer relations, operational efficiency or improving the capture and sharing of knowledge.

390. **It is recommended to collect data on the objectives or effects of innovations implemented by enterprises during the period under review. It is recommended to use an ordinal scale to ask enterprises whether the factor is relevant and, if so, its importance**. Questions on both the objectives of innovation and their actual effects can provide valuable information on enterprises' innovation activity. However, it may not be possible to include both questions in innovation surveys. The choice between the two questions may depend on which is considered most useful for policy. However, a drawback of questions on effects is that the impact of recent innovations may not be felt within the time period of the survey. The disadvantage of questions on objectives is that the actual effects may differ substantially from expectations.

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Table 7.1. **Factors relating to the objectives and effects of innovation**

Relevant for:	Product innovations	Process innovations	Organisational innovations	Marketing innovations
Competition, demand and markets				
Replace products being phased out	*			
Increase range of goods and services	*			
Develop environment-friendly products	*			
Increase or maintain market share	*			*
Enter new markets	*			*
Increase visibility or exposure for products				*
Reduced time to respond to customer needs		*	*	
Production and delivery				
Improve quality of goods and services	*	*	*	
Improve flexibility of production or service provision		*	*	
Increase capacity of production or service provision		*	*	
Reduce unit labour costs		*	*	
Reduce consumption of materials and energy	*	*	*	
Reduce product design costs		*	*	
Reduce production lead times		*	*	
Achieve industry technical standards	*	*	*	
Reduce operating costs for service provision		*	*	
Increase efficiency or speed of supplying and/or delivering goods or services		*	*	
Improve IT capabilities		*	*	
Workplace organisation				
Improve communication and interaction among different business activities			*	
Increase sharing or transferring of knowledge with other organisations			*	
Increase the ability to adapt to different client demands			*	*
Develop stronger relationships with customers			*	*
Improve working conditions		*	*	
Other				
Reduce environmental impacts or improve health and safety	*	*	*	
Meet regulatory requirements	*	*	*	

391. Questions on objectives or effects may either refer to all types of innovations or to a subset of these, such as product and process innovations. Limiting the types of innovations these questions refer to can facilitate interpretation of the data (given that most factors are relevant for at least two types, for example product and marketing innovations or process and organisational innovations). An additional option is to include questions for each innovation type (or subsets of types) separately.

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3. Other measures of impacts on enterprise performance

392. This section considers output indicators in addition to those discussed in Section 2, in particular quantitative indicators of innovation performance.

393. The success of an innovation may depend on a number of factors. It will clearly depend on the quality of the innovation. The impact of innovations may also vary greatly from sector to sector or region to region. In addition, it may depend on other changes in the enterprise that support the innovations. For example, the success of product innovations may depend to a large degree on marketing initiatives to launch the product. Likewise, the impact of process innovations may depend on organisational changes to take advantage of these new processes. A well-documented example is the importance of organisational changes for the impact of investments in information and communication technology (ICT) on productivity (Brynjolfsson and Hitt, 2000; OECD, 2004).

394. It is generally difficult to ask for quantitative measures of the effects of innovations in surveys, even for very rough estimates, as the calculations often require substantial analysis on the part of the enterprise. This section discusses some output indicators that might be used in innovation surveys.

395. An important aspect for all analyses of the impact of innovations is the time lag between an innovation and its impact. Some effects may materialise over the course of the observation period, while others may take longer. The availability of innovation data on a large cross-section over time (*i.e.* panel data) is of great value for such analyses. Panel surveys can open up interesting possibilities for analysing the results of innovation.

396. To help create a view of how innovation affects overall performance, some general data on the enterprise can be collected for the beginning and end of the observation period, such as data on turnover, exports, employees and operating margins. These data can be used in subsequent analysis to examine the effect of various indicators on these variables. Data can be collected via the innovation survey or taken from other available sources.

3.1. Impact on turnover

3.1.1. Proportion of turnover due to new or significantly improved products

397. An indicator on the proportion of turnover due to new or significantly improved products provides important information on the impact of product innovations on the overall makeup of turnover (*i.e.* the share of turnover from new products) and on the degree of innovativeness of the enterprise.

398. Questions on the proportion of turnover due to product innovations should refer to the impact of product innovation over the observation period

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on turnover in the reference year (*i.e.* the last year of the observation period). **It is recommended to ask enterprises to estimate the percentage share of total turnover in the reference year that is due to:**

- New or significantly improved goods and services introduced during the observation period that were **new to the market** (as defined in Chapter 3).
- New and significantly improved goods and services introduced during the observation period that were **new to the firm, though not new to the market.**
- Products that were **unchanged or only marginally modified** during the observation period.

399. A number of firms may have come into existence during the period under review. This includes both newly established firms and firms that are the result of mergers, demergers and other kinds of reorganisation. These firms should be treated like all other firms when constructing this indicator.

400. Respondents should supply their best estimates of actual percentages. When presenting the results by industry, firm size, region or country, the percentages should be calculated as the ratio of total turnover due to new products to total turnover for the industry, etc.

Product life cycles

401. Outcome indicators are directly affected by the length of product life cycles. They are likely to be higher in product groups with short life cycles and innovation is expected to take place more frequently.

402. In order to take the effects of product life cycles into account, an option is to ask enterprises to estimate the average length of their products' life cycles. This information may be used to weight the outcome indicators for turnover shares. An alternative way of formulating this question is to ask how often the enterprise generally introduces innovations.

3.1.2. *Process innovations*

403. Innovation surveys can also ask enterprises to estimate the percentage of turnover that is affected by process innovations. This can provide an indication of how extensive process innovations are in terms of the enterprise's total operations.

3.1.3. *Marketing innovations*

404. The development and implementation of marketing innovations constitutes an important innovation activity for many enterprises in terms of impact on performance. To gain an idea of the scope of marketing innovations, enterprises might be asked to estimate the percentage of total turnover that is affected by marketing innovations. Innovation surveys can

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ask two separate questions concerning marketing innovations. One asks for an estimate of the percentage of turnover due to goods and services with significant improvements in product design or packaging. The second asks for an estimate of the share of turnover affected by new marketing methods in pricing, promotion or placement. Note that questions on share of turnover due to changes in product design should not be combined with questions on share of turnover due to product innovations (*i.e.* these two questions should be separate), since some new or improved products might be both product and marketing innovations. Nor should questions on new marketing methods in product design be combined with questions on the share of turnover due to other new marketing methods. As with other questions concerning the impact on turnover, enterprises will likely only be able to provide rough estimates at best.

3.2. The impact of process innovations on costs and employment

405. As described in Section 2, innovation surveys can include questions on the effects of innovations and their relative importance. An option for obtaining additional information on process innovations is through questions on their impacts on costs or employment.

406. There are a number of options for asking questions on the impact of process innovations on costs. Enterprises can be asked first, whether process innovations implemented during the observation period led to an increase, decrease or no change in costs. A "yes" response to a decrease or increase can be followed by further questions to quantify the amount of change.

407. These questions can either be asked with respect to average costs or to specific costs, for example changes in the cost of material, energy or labour inputs. Quantitative questions can either ask for an interval estimate of the percentage change in costs, or ask enterprises to choose from a set of pre-defined categories (*e.g.* an increase or decrease of less than 5%, 5% to 25%, over 25%). Experience from earlier surveys indicates that enterprises find the latter method easier to answer and thus results in much higher item response rates. The same techniques can also be used to ask about the effect of process innovations on employment, *i.e.* whether employment increased or decreased, and by how much.

408. This approach can also be used for organisational innovations. In this case, questions should be asked with respect to average costs as opposed to specific costs.

3.3. The impact of innovation on productivity

409. Concerning impacts on productivity, a number of questions are of great interest, for example whether process innovations or organisational innovations

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improve efficiency. A detailed examination of these issues would require separate analyses using both innovation data and other economic data on firm performance. In many cases, panel data on innovation would be necessary, though some analysis can be performed using innovation data from a single survey combined with economic data for more than one year. An example is empirical analyses of ICT investments and organisational innovation, which generally have found that the effects of ICT investments on productivity depend greatly on organisational innovations (Brynjolfsson and Hitt, 2000).

4. Factors hampering innovation activities

410. Innovation activity may be hampered by a number of factors. There may be reasons for not starting innovation activities at all, or factors that slow innovation activity or have a negative effect on expected results. These include economic factors, such as high costs or lack of demand, enterprise factors, such as a lack of skilled personnel or knowledge, and legal factors, such as regulations or tax rules.

411. Questions on barriers to innovation can provide information on a number of issues relevant for innovation policy. Small and medium sized enterprises (SMEs) may identify a lack of available finance as an important barrier to investments in innovation. Enterprises may be concerned about a lack of demand for new products at the prices that enterprises would need to charge to make the innovation worthwhile. Enterprises may not have the skilled personnel needed to engage in innovation activities, or their innovation activities may be slowed because they are unable to find the necessary personnel on the labour market. A lack of infrastructure may be an important barrier to innovation, in particular outside of large cities. Other reasons may be that the enterprise lacks knowledge relating to technologies or markets that would be needed to develop an innovation, or that the enterprise is unable to find suitable partners for joint innovation projects. Table 7.2 lists factors that could act as barriers to innovation.

412. These barriers can be related to a specific type of innovation or to all types. For example, cost factors can be relevant for all types of innovations, and market factors can affect both the development of product innovations and work on product design (*i.e.* marketing innovations). The table also shows which types of innovations are relevant for each barrier.

413. It is **recommended to collect data on barriers to innovation activity and their relative importance for the period under review. Questions on barriers to innovation activity should be asked of both innovative and non-innovative enterprises.** Questions on barriers can refer to all types of innovations or to a subset of types, such as product and process innovations.

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Table 7.2. **Factors hampering innovation activities**

Relevant for:	Product innovations	Process innovations	Organisational innovations	Marketing innovations
Cost factors:				
Excessive perceived risks	*	*	*	*
Cost too high	*	*	*	*
Lack of funds within the enterprise	*	*	*	*
Lack of finance from sources outside the enterprise:				
Venture capital	*	*	*	*
Public sources of funding	*	*	*	*
Knowledge factors:				
Innovation potential (R&D, design, etc.) insufficient	*	*		*
Lack of qualified personnel:				
Within the enterprise	*	*		*
In the labour market	*	*		*
Lack of information on technology	*	*		
Lack of information on markets	*			*
Deficiencies in the availability of external services	*	*	*	*
Difficulty in finding co-operation partners for:				
Product or process development	*	*		
Marketing partnerships				*
Organisational rigidities within the enterprise:				
Attitude of personnel towards change	*	*	*	*
Attitude of managers towards change	*	*	*	*
Managerial structure of enterprise	*	*	*	*
Inability to devote staff to innovation activity due to production requirements	*	*		
Market factors:				
Uncertain demand for innovative goods or services	*			*
Potential market dominated by established enterprises	*			*
Institutional factors:				
Lack of infrastructure	*	*		*
Weakness of property rights	*			*
Legislation, regulations, standards, taxation	*	*		*
Other reasons for not innovating:				
No need to innovate due to earlier innovations	*	*	*	*
No need because of lack of demand for innovations	*			*

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5. Questions on the appropriability of innovations

414. The ability of enterprises to appropriate the gains from their innovation activities is an important factor affecting innovation. If, for example, enterprises are unable to protect their innovations from imitations by competitors, they will have less incentive to innovate. On the other hand, if an industry functions well without formal protection methods, promoting these may slow the flow of knowledge and technology and lead to higher prices for goods and services.

415. Policy plays a central role in the design of legal methods of protecting innovations. Data on which types of methods are used and their relative importance can help inform policies to maximise the economic and social benefits from intellectual property rights.

416. The following list of methods of protection is suggested:

Formal methods:

- Patents.
- Registration of design.
- Trademarks.
- Copyrights.
- Confidentiality agreements and trade secrecy.

Informal methods:

- Secrecy that is not covered by legal agreements.
- Complexity of product design.
- Lead time advantage over competitors.

An additional formal method that is used in some countries is petty patents or utility patents, which are rights for protection of inventions that are granted without any formal review.

417. Patent data, both applications and grants, function as an intermediate output indicator for innovation activity and also provide information on the innovative capabilities of the enterprise. For example, an enterprise that has applied for patents can be assumed to be capable of developing innovations that are new to the world (occasionally only new to the market, depending on the patent strategies of other firms). Data on whether or not enterprises have applied for or been granted a patent can thus provide useful data for innovation surveys and be used in specialised surveys on intellectual property rights (IPR). Note that patent data should refer to the country where the patent was developed and not the country where the patent application was made. Patent data is discussed in greater detail in the *Patent Manual* (OECD, 1994).

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418. Registration of design is primarily a method of protecting the aesthetic design of products, to prevent other enterprises from using it. Enterprises may also register trademarks related to the enterprise as a whole or a product line, thereby protecting the enterprise's image and the association of products with the enterprise. Copyrights relate to the final use of some types of products and establish rights to claim payment for the use of copyright-protected products.

419. Patents are methods for protecting research and development results. Confidentiality agreements between enterprises and other organisations are also designed to protect R&D work, while at the same time allowing the enterprise to interact with other organisations on this work.

420. **It is recommended to collect data on whether or not enterprises have used various methods of protection for their innovations during the observation period**. Questions can either use a binary or an ordinal scale. Protection methods can be relevant for all types of innovations, though asking questions for all innovation types combined can make it more difficult to interpret the data (*i.e.* to link protection methods to specific types of innovations).

421. Among the options for questions on methods of protection are:

- Refer to product and process innovation only. A supplementary question could be asked on marketing and organisational innovations (*e.g.* whether any formal methods of protection were used for these innovations). An ordinal scale can be used to ask about the relative importance of different methods.
- Refer to all types of innovations combined. An ordinal scale could be used.
- Refer to each individual innovation type, allowing enterprises to choose those innovations that are relevant for each protection method. This would allow the greatest level of detail on the use of protection methods, such as which formal methods are used for marketing methods, which innovations patents are used for, and whether secrecy or other methods are used for organisational or other innovations.

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Oslo Manual: Guidelines for Collecting and Interpreting Innovation Data

Chapter 8

Survey Procedures

1. Introduction

422. The correct application of statistical methodology is crucial for the collection and analysis of innovation data. Based on theoretical knowledge and on practical experience in recent innovation surveys at national and international levels, this chapter discusses and provides guidelines on central elements of the collection and analysis of innovation data.

423. Following these guidelines will generally lead to comparable results over time and across countries. Particular circumstances may require a country to use another methodology. In such cases, the methods used should be considered carefully so as to ensure that the results remain comparable. Divergence from the guidelines should be documented in sufficient detail to explain comparability issues with data from other countries.

2. Populations

2.1. The target population

424. Innovation activities take place in all parts of an economy: in manufacturing, the service industries, public administrations, the health sector and even private households. In reality, for various theoretical and practical reasons, a survey will not cover all possible units. The concept of innovation may be less clear in some parts of the economy, especially for non-market-oriented activities.

425. As discussed in Chapter 1, it is therefore recommended that innovation surveys should refer to innovation activities in the business enterprise sector. Hence, the target population for innovation surveys concerns statistical units (innovators and non-innovators, R&D performers and non-R&D performers) in the business enterprise sector. This sector includes both goods-producing and services industries. A proposed list of industrial classifications to be included in the target population for innovation surveys is shown in Chapter 4.

426. Innovative activities take place in small and medium-sized units as well as in large units. In order to capture innovation activity in these smaller units, **it is recommended that the target population should include, at a minimum, all statistical units with at least ten employees.** This threshold may be higher for specific industries, such as Construction and Retail trade. Surveys may also find it useful to include units with *fewer* than ten employees. Innovation activities in these smaller units are of considerable policy interest

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for a number of sectors, such as high-technology manufacturing and knowledge-intensive services.

2.2. The frame population

427. The units from which a survey sample or census is drawn form the **frame population**. When preparing a survey, the target and frame populations should be as close as possible. In practice, the population from which the sample or census is drawn may not be the same as the target population. For example, the frame population underlying the survey (such as a register) may include units that no longer exist, or units that no longer belong to the target population. At the same time, it may not contain units that in fact do belong to the target population.

428. The frame population is based on the last year of the observation period for surveys. Special attention should be paid to a number of changes to units that may have taken place during the observation period. Among these are: changes in industrial classifications, new units created during the period, mergers, splits of units, and units that ceased activities during the last year of the period.

429. An ideal frame is an up-to-date official business register established for statistical purposes. National statistical offices usually keep such registers. Other registers can be used as well, provided their quality is comparable to that of the official register. The units in the register will in many countries be legal units, so the units may not all be statistical units in terms of the innovation survey, as defined in Chapter 4. Guidelines to check the validity of the responding statistical unit should be given in the questionnaire.

430. If the register forms the basis for several surveys, such as the innovation survey, the R&D survey and the general business statistics survey, the information collected in the innovation survey can be restricted to issues specific to innovation. Other information, for example on R&D or on general economic variables such as employment, turnover, exports or investments, can be taken directly from the other surveys based on the register. Accordingly, it is desirable to base different types of surveys on a single business register compiled for statistical purposes.

3. Survey methods

3.1. Mandatory or voluntary survey

431. Innovation surveys can be either mandatory or voluntary. If they are voluntary, higher non-response rates should be expected. Low response rates mean a smaller sample than expected and thus higher variance. This can be compensated to some extent, in the case of sample surveys, by higher sampling fractions. However, increasing the sampling fractions does not solve

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the basic problem of bias in the estimates for the target population that is due to a high non-response rate, making further analyses less representative.

3.2. Census or sample survey

432. Innovation data can be collected through census or sample surveys. Resource limitations and response burdens will in most cases rule out a survey of the entire population (census). If sample surveys are utilised, the units should be selected on the basis of a random procedure (random sample surveys with known selection probabilities). Sample surveys should be representative of the basic characteristics of the target population, such as industry, size and region, so a stratified sample is necessary.

433. A census may be unavoidable in some cases. It may be a legal requirement that all business surveys must be censuses. In addition, when the frame population is fairly small (*e.g.* in small countries), proper sampling may produce sample sizes for some strata that are relatively close in size to the frame population of the strata. In such cases censuses may be worth considering. Finally, it may be decided that all units in the frame with more than a given number of employees should be included.

434. For sample surveys, the sample of enterprises should be large enough to give reliable results for the units in the target population and characteristics of interest in the target population, such as specific sectors. Estimates of acceptable coefficients of variation can be used to estimate the required number of responses for reliable results. The total sampling fraction will vary depending on the size of the total frame population, while the sampling fractions of each stratum will depend on the number of units, the size of the units and the variability of the main indicators. In general, the necessary sample fraction will decrease with the number of units in the population and increase with the size of the units and the variability of the sample.

3.3. Domains

435. Particular subsets of the target population may be of special interest to users or users may need detailed information at sector or regional levels. These subsets are called domains (or sub-populations). To get representative results for the domains, the domains must be subsets of the sampling strata. The most frequent approach is "over-allocation" in order to produce reliable results for the domains. Additionally, establishing domains may allow for the co-ordination of different business enterprise surveys, as well as for comparisons over time between enterprises with similar characteristics. Some potential sub-populations that can be considered are: industry groupings, size classes, regions, units that engage in R&D and innovation-active units.

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436. Some guidelines for the use of domains are:

- Statistical units and classifications should be the same in all parts of the sample including domains.
- Methods used (*e.g.* weighting methods) to calculate results for subsets should be consistent with those used for results from the main sample.
- Deviations in data treatment or differences in the quality of the results from the domains should be documented.

3.4. Sampling techniques

437. Innovation surveys are in general random sample surveys. The relevant literature offers various sampling techniques, such as the simple random sample technique, stratification techniques, cluster sample techniques and pps-sample[1] techniques. The techniques may even be combined. In the past, stratified sample surveys have proved to lead to reliable results.

438. If stratification techniques are used, some general rules should be observed with regard to the selection of the stratification variables. In principle, stratification of the population should lead to strata that are as homogeneous as possible in terms of their innovation or non-innovation activities. Given that the innovation activities of units in different industries and in different size classes can differ significantly, it is **recommended that the stratification of random sample innovation surveys should be based on the size and principal activity of the units.**

439. The size of units should be measured by number of employees. Recommended size classes are provided in Chapter 4. Some recommendations for analytical purposes, which might also be used for stratification, are given below.

440. The stratification of units according to their principal activities should be based on the ISIC Rev. 3.1/NACE Rev. 1.1 classifications. The classification level largely depends on national circumstances. Take as an example an economy specialised in the production of wood (Division 20 of ISIC Rev. 3.1/ NACE Rev. 1.1). For this country a further subdivision at group or even class level might be useful, but would not be useful in another economy in which wood production is unimportant. However, sampling strata should not be aggregated above the division level (second-digit level of ISIC Rev. 3.1/ NACE Rev. 1.1).

441. If regional aspects are of importance, the stratification should also include a regional dimension. An appropriate regional classification should be used. See the discussion of regional analyses in Chapter 4.

442. Sampling fractions should not be the same for all strata. It is generally recommended that the sampling fraction of a stratum should be higher for

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more heterogeneous strata (optimal allocation), and also higher for smaller strata. The sampling fractions should be up to 100% in strata with only a few units, as may be the case in strata consisting of large units in certain industries (or certain regions). The size of the units should also be taken into consideration by using the pps-sampling approach and thus using lower sampling fractions in strata with smaller units. Also, the units in each stratum may be sorted by size or turnover and then sampled systematically. Another factor, which should be taken into account when fixing the individual sampling fractions, is the expected response rate in each stratum.

3.5. *Panel data surveys*

443. The standard approach for innovation surveys is *repeated cross-sections*, where a new random sample is drawn from a given population for each innovation survey. An alternative or supplementary approach is to impose an explicit *panel data* structure, whereby a given sample of units is surveyed more frequently and in every subsequent survey using the same set of questions.

444. Panel data provide the opportunity to follow the development over time of the innovation process at the microeconomic level. In particular, it allows for the analysis of effects of various innovation indicators over time on economic variables such as sales, productivity, exports and employees.

445. Panel data surveys can be conducted in parallel to larger cross-sectional innovation surveys. However, a number of guidelines should be followed:

- Units should be integrated with full-scale cross-sectional surveys in years in which both are conducted, in order to reduce burdens on units and to ensure an acceptable level of consistency between the results from the two surveys.
- Panels should be constructed in such a way that they do not affect the main cross-sectional survey.
- If possible, information from other surveys on employment, sales, value added and investment should be linked to the panel survey as well as the larger cross-sectional innovation survey for empirical analyses.

3.6. *Survey methods and suitable respondents*

446. A variety of methods can be used to conduct innovation surveys, including postal surveys and personal interviews. Each of these methods has different strengths and weaknesses. Postal surveys are well established and comparatively less expensive, but may present problems. Several reminders, including telephone reminders, are usually necessary to increase response rates to an acceptable level. Actions that can be taken to increase response rates further include: contacting respondents prior to conducting the survey,

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sending a cover letter from the minister, sending basic results of previous innovation surveys, providing the possibility of reporting to an "intelligent questionnaire" via the Internet or a promise to send respondents the main findings from the current survey.[2]

447. Many of the problems with postal surveys can be avoided when data are collected by personal interview, using for example, CATI or CAPI techniques. Interviewers can give guidelines on answering the questionnaire. The quality of the results for CAPI (computer-assisted personal interviews) techniques is in general expected to be higher and item non-response rates are expected to be lower. However, CAPI methods in particular are more costly than postal surveys.

448. A drawback to CATI (computer-assisted telephone interviews) is the question of collecting quantitative data on innovation activity. This generally takes time to calculate, so that respondents may not be able to answer the entire questionnaire in a single call. Additionally, in large units, questionnaires are answered jointly by different offices or branches, so that several calls may be needed to complete a single questionnaire.

449. An alternative approach is the use of online or automated data exchange collection technologies. It presents a difference in terms of the use of filtering questions. In a paper questionnaire respondents see all questions and are able to modify their responses to a filtering question. An electronic questionnaire can be designed so that respondents do not see all questions and therefore cannot alter their answers in light of additional information (the same may be true for CATI and CAPI formats). One option could be to allow all respondents to see the entire questionnaire, including the questions that respondents may not be required to answer. This approach also raises issues of confidentiality and continuity (*e.g.* returning to the questionnaire several times before it is finished).

450. Choosing the unit's most suitable respondent is particularly important in innovation surveys, as the questions are very specialised and can be answered by only a few people in the unit, often not those who complete other statistical questionnaires. In small units, managing directors are often good respondents. In larger units, several people are often involved, but one must be responsible for co-ordinating the replies. **It is highly recommended to make a special effort to identify respondents by name before data collection starts.**

3.7. The questionnaire

451. Some basic rules should be followed when designing the questionnaire for an innovation survey. Each questionnaire should be tested before it is used in the field (pre-test). Pre-testing can include interviewing a group of

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managers or experts concerning their understanding of the draft questionnaire and sending the questionnaire to a small sample of units. Both steps can be valuable for improving the quality of the questionnaire.

452. The questionnaire should be as simple and short as possible, logically structured, and have clear definitions and instructions. Generally, the longer the questionnaire, the lower the unit and item response rates. This effect can be minimised by devoting special attention to design and layout and by giving clear and sufficient explanatory notes and examples. It is particularly important to design the questionnaire in such a way that units with no innovation activities will nonetheless reply and answer the questions that are relevant for them.

453. Respondents' understanding of the questionnaire may well increase as they move from question to question. This means that their answers may depend on the order of the questions. Adding or deleting a question may influence subsequent answers.

454. Questions on a number of qualitative indicators can use either a binary scale (yes or no), or an ordinal scale, *e.g.* when enterprises are asked whether the factor is relevant and, if so, its importance. The binary scale has the advantage of being simple and reliable, but it provides only limited information on the factors considered. However, it may introduce a high degree of subjectivity if the answer cannot be based on facts, owing to differences in the interpretation of the question. An ordinal scale allows the ranking of factors in terms of their importance, although this also introduces a degree of subjectivity. Analytical methods are available, however, to minimise such problems with ordinal response scales.

455. In the case of international innovation surveys, special attention should be given to the translation and design of the questionnaire. Even minor differences between national questionnaires can restrict the comparability of the results. Such differences can stem, for example, from translation, from changes in the order of questions, or from adding or deleting categories. A sound translation which takes account of particular local circumstances (such as a country's legal system) will help avoid misunderstandings of concepts and definitions.

3.7.1. Short-form questionnaires

456. For many small units and units in sectors with little innovation activity, the response burden for a full innovation questionnaire may be quite large relative to their innovation activity. Unit non-response rates may also be higher for these units. In such cases, shorter survey questionnaires that focus on a set of core questions can be useful. Short-form questionnaires can also be used in surveying units that have not reported innovation activity in previous

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innovation surveys. Conversely, for individual units in the above-mentioned groups (small units or less innovative sectors) which have previously reported substantial innovation activity, full questionnaires may be used.

3.8. Innovation and R&D surveys

457. Because R&D and innovation are related phenomena, some countries may consider the combination of R&D and innovation surveys. There are a number of arguments for and against:

- With a combined survey, the overall response burden of the reporting units will be reduced (a single questionnaire, instead of two separate surveys asking some of the same questions).
- If the length of the questionnaire for combined surveys is much longer than for a separate survey, response rates may decline.
- A combined survey offers scope for analysing the relations between R&D and innovation activities at the unit level. There is less scope for this with separate surveys, especially when these are carried out by different institutions.
- There is a risk that units not familiar with the concepts of R&D and innovation may confuse them in a combined survey.
- Combined surveys offer an efficient method of increasing the frequency of innovation surveys.
- Country experiences (for example, Denmark, Finland, the Netherlands, Norway and Spain) indicate that it is possible to obtain reliable results for R&D expenditures in combined surveys.
- The frames for the two surveys are generally different. For example, the frame population for innovation surveys may cover industrial classifications (and small units) that are not included in R&D surveys. Combining them may involve sending questions about R&D to a large number of non-R&D performers that are included in the frame population for the innovation survey. This would increase the cost of the joint survey.

458. In principle, business surveys other than for R&D can also be merged with innovation surveys. Some experiences in merging innovation surveys with structural business surveys have been conducted (for example, Bulgaria, Italy and the Netherlands). Additionally, business surveys on the diffusion of ICTs, and on the adoption of knowledge management practices can be considered for integration with innovation surveys.

459. While the Manual does not recommend the use of combined surveys, country experience indicates that they provide a feasible option for increasing

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the frequency of data collection. Some guidelines for conducting combined surveys are:

- In order to reduce the risk of conceptual confusion between R&D and innovation, the questionnaire should have two distinct sections. Separate sections should also be used when combining innovation with other types of surveys.
- To avoid declines in response rates, individual sections for R&D and innovation should be smaller than in separate surveys, so that the overall length of the combined survey is comparable to that of a separate survey.
- Comparisons of results from combined surveys with those from separate innovation surveys should be done with care, and surveying methods should be reported.
- Samples to carry out such surveys should be extracted from a common business register in order to avoid inconsistencies in the frame populations.

4. Estimation of results

4.1. *Weighting methods*

460. The results of sample surveys need to be weighted to obtain information that is representative for the target population. There are various methods for weighting sampling results. The simplest is weighting by the inverse of the sampling fractions of the sampling units, corrected by the unit non-response. If a stratified sampling technique with different sampling fractions is used, weights should be calculated individually for each stratum.

461. The weights can be further refined by calibration if the frame population includes some quantitative or qualitative information on all units, such as number of employees, turnover, legal status or region. The calibration will ensure that the weighted sample sums to the total population or distribution and in that way will increase precision and reduce bias. Effective calibration software, in particular CLAN from Statistics Sweden, CALMAR from INSEE (France) and CALJACK from Statistics Canada, are available for use by other countries.

462. Weights are most commonly based on the number of enterprises in a stratum. However, it may be beneficial for quantitative variables to weight the results by number of employees or turnover. In international and other comparisons it is important to ensure that the same weighting method is used.

4.2. *Non-response*

463. In practice responses to innovation surveys are always incomplete, irrespective of the survey method used. Two types of missing values can be

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distinguished: item and unit non-responses. *Unit non-response* means that a reporting unit does not reply at all. Possible reasons are, for example, that the surveying institute cannot reach the reporting unit or that the reporting unit refuses to answer. In contrast, *item non-response* refers to the response rate to a specific question and is equal to the percentage of blank or missing answers among the reporting units. Item non-response rates are frequently higher for quantitative questions than for questions using binary or ordinal response categories.

464. Item and unit non-responses would be less a problem if the missing values were randomly distributed over all sampling units and all questions. In reality, however, both types of missing values may be biased with respect to certain characteristics of the population and the questionnaire.

465. Disregarding missing values and applying simple weighting procedures based only on the responses received implicitly assumes that non-respondents are distributed in the same way as respondents. If non-respondents do not follow the same distribution, for example if non-response units have a lower propensity to innovate, this practice will give biased results.

466. A number of methods can be used to minimise the problems of non-response. As different methods may lead to different results, some general guidelines should be followed. An appropriate first step in dealing with missing values is to contact the respondent to collect the missing information.

467. For practical as well as theoretical reasons, one way to minimise the problem of item non-response is to use imputation methods to estimate missing values on the basis of additional information. The idea is that the use of additional information will allow more accurate estimates of missing values than simply using the mean observed value and will minimise non-response bias.

468. Among imputation methods, cold-deck techniques can be employed first, in which missing information is estimated using data from other statistical surveys (including previous surveys) or from other related sources. For any remaining missing values, surveys may consider hot-deck methods. Hot-deck methods cover a large variety of options, such as replacing the missing values for each variable by the mean of the strata, by predicting the value using regression techniques, or by using nearest neighbour techniques where the missing values are replaced by the values of the unit which is most similar with respect to other relevant variables. The decision about the most appropriate hot-deck method should also be based on the type of variable (quantitative or qualitative).

469. The choice of method to treat the problem of unit non-response will depend on the level of non-response. If the non-response rate is fairly low,[3] the weighting should be calculated on the basis of the units that replied. This

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procedure assumes that the innovative behaviour of responding and non-responding units is identical. The assumption can be tested through a non-response analysis. Even if the assumption is wrong, the bias introduced can be disregarded if the fraction of non-responding units is fairly small.

470. In contrast, if the unit non-response rate is very high, no method can be recommended to solve the problem. In such a case the results of the innovation survey can only be used as case studies. No conclusions should be drawn about the target population in general, as the bias may be too great.

471. In all other cases, *i.e.* when the unit non-response rate is above a lower threshold but below an upper threshold, some more complicated and partly more expensive techniques can be used. One is to select reporting units that have answered randomly until the response rate is 100%, *i.e.* to use the results of randomly selected units twice or even more often.

472. Other methods are based on the results of a *non-response analysis*. The objective of non-response analysis is to obtain information on why reporting units did not answer. Non-reporting units should be contacted by phone or by mail (using a very simple questionnaire not exceeding one page) and should be asked for general information such as their sector of activity and size (if not already available from other sources), the reason why they did not answer. They should be asked to answer a few key questions in the original survey to see whether the results are biased. This information can then be used to adjust the weights. The results of the non-response analysis should only be used if the response rate is very high.

5. Presentation of results

473. The results of innovation surveys can be used either for descriptive or for inferential analysis. The objective of *descriptive analysis* is to describe the statistical units in terms of their innovative or non-innovative activities without drawing any conclusions about the underlying survey or target population (if it is not a census). In this type of analysis the results are taken without further weighting, as observed for the individual units. No generalisation of the results at the level of the survey or target population is possible, because the figures only refer to the participating units. For this kind of analysis, unit non-response rate is of minor importance.

474. In contrast, the objective of *inferential analysis* is to draw conclusions about the target population. In this case the results should give a representative estimation of the situation for the observed and unobserved statistical units taken together. Inferential analysis requires weighted results. For this type of analysis, the unit non-response rate is very important: if the unit non-response rate exceeds a certain threshold, the potential bias may be so large that inferential analysis is useless.

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475. As mentioned above, most innovation surveys are carried out as random sample surveys. The results of these surveys will include two types of error: random errors due to the random process used to select the units, and systematic errors containing all non-random errors (bias). To get at least an idea of the variance for the results, **it is recommended to calculate both (average) values for innovation indicators and also their coefficients of variation and/or confidence intervals.** Such intervals include the true but unknown values in the survey population with a very high probability, assuming no bias. Standard errors give a lower threshold for the unknown total error of the indicators under consideration.

476. The presentation of results should contain metadata, including information on the procedure used to collect data, sampling methods, procedures for dealing with non-response and quality indicators. This will allow users to better interpret the data and judge its quality.

6. Frequency of data collection

477. Theoretical and practical considerations, as well as user needs at the international, national and regional level, determine the frequency of innovation surveys. The increasing importance of innovation for the growth of economies requires more frequent and more up-to-date data. From this viewpoint, information on innovation activities should ideally be collected annually. Moreover, theoretical considerations indicate that innovation activities occur in waves so that the results of less regular surveys very dependent on the time when the survey is carried out. Only a few countries, however, can afford or are willing to run innovation surveys every year.

478. Taking into account both practical considerations and user needs, **it is recommended to conduct innovation surveys every two years. However, where this is not economically feasible, a frequency of three or four years may be chosen.**

479. To ensure comparability among respondents, surveys must specify an **observation period** for questions on innovation. The choice of the length of the observation period is a compromise between different requirements. A long observation period allows for the collection of data on intermittent innovation activities and the effects of innovations. For example, firms with products that have longer life cycles may innovate less frequently. Conversely, a short observation period improves respondent recall and the accuracy of the results. For longer observation periods, organisational memory may be poor, owing either to staff turnover or to less reliable respondent recall. Other issues concern the relation between the frequency of collection and the observation period. An observation period that is longer than the frequency of collection (creating overlap in the coverage of innovation surveys) has some drawbacks.

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The overlap in coverage may make it difficult to attribute innovation fully to the time period since the preceding survey. It can also affect comparison of results over time, since it may be unclear whether changes in results are mainly due to innovation activities in the period since the last survey or in the year that is also covered in the previous survey. As stated in Chapter 3, Section 8, **it is recommended that the length of the observation period for innovation surveys should not exceed three years nor be less than one year.**

Notes

1. pps-sampling = The units are included with **P**robabilities **P**roportional to their **S**ize, often measured as number of employees in the business sector.
2. Further guidelines for improving response rates for postal surveys can be found in Dillman (1978) and in Moore and Baxter (1993).
3. It is difficult, if not impossible, to define when a unit non-response rate is deemed to be high or low. However, it is generally acknowledged that the higher the unit non-response rate, the lower the comparability of the results of innovation surveys.

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ANNEX A

Innovation Surveys in Developing Countries

1. Introduction

480. This annex provides guidelines for the implementation of innovation surveys in developing countries. The term "developing countries" is used here with the assumption that it does not refer to a homogeneous set of countries, and that the annex needs to reflect the different characteristics of economies and societies in a rapidly evolving "developing world".

481. After the publication of the second edition of the *Oslo Manual*, many developing countries in various regions of the world conducted innovation surveys. The design of these surveys was usually intended to comply with *Oslo Manual* standards. However, almost all of these innovation measurement exercises resulted in adaptations of the proposed methodologies, in order to capture the particular characteristics of innovation processes in countries with economic and social structures different from those of the more developed OECD countries. These adaptations were prepared by each country and adopted different approaches. Outside the OECD and EU, the first effort to compile these particularities and guide the design of cross-nationally comparable innovation surveys was conducted in Latin America by RICYT (Ibero-American Network on Science and Technology Indicators – *Red Iberoamericana de Indicadores de Ciencia y Tecnología*) and resulted in the publication of the Bogotá Manual, which was later used in most innovation surveys conducted in Latin American countries and extended to other regions. The importance and impact of this standard-setting work inspired the production of this annex.

482. Preparation of the annex was co-ordinated by the UNESCO Institute for Statistics (UIS). A base document provided by RICYT[1] was submitted to a panel of researchers and practitioners with experience in innovation surveys in developing countries.[2] This annex is based on the conclusions of this exercise. Proposals and recommendations may be more or less applicable depending on the characteristics of the region and countries concerned.

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483. Recommendations in this annex are mainly based on the experience of countries that have already conducted innovation surveys, most of which are among the higher- and medium-income countries of the developing world, where innovation has already become a policy issue. Nevertheless, the knowledge gained by these countries should help other developing countries to acquire their own experience without having to build exclusively on innovation measurement exercises carried out in developed countries.

2. The characteristics of innovation in developing countries

484. It is widely accepted that dissemination mechanisms and incremental change account for most of the innovation occurring in developing countries,[3] owing to the particular characteristics of the society and the economy in many of these countries which influence innovation processes in many ways.

2.1. Size and structure of markets and firms

485. It is important to know about the size and structure of firms and markets in order to understand developing countries' innovation processes. While the sector of small and medium-sized enterprises (SMEs) is very significant (including a large number of micro and small and, in some countries, medium-sized businesses which are often not registered), even enterprises considered "large" in most developing countries usually operate at suboptimal production scales, with higher unit costs and far from optimal efficiency. Competitiveness is mostly based on the exploitation of natural resources or cheap labour, rather than on efficiency or differentiated products. This leads to an informal organisation of innovation and fewer R&D projects.

486. Important market failures related to economies of scale and externalities present high barriers to innovation. For instance, productive processes and, more specifically, innovation activities are subject to indivisibilities and a lack of economies of scale, and this influences the viability of R&D projects.

2.2. The innovation landscape in developing countries

487. A number of exogenous systemic factors shape the innovation landscape in developing countries, such as: macroeconomic uncertainty; instability; physical infrastructure (lack of basic services such as electricity or "old" communications technologies); institutional fragility; lack of social awareness about innovation; risk-averse nature of enterprises; lack of entrepreneurs; existence of barriers to business start-up; lack of public policy instruments for business support and management training.

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2.2.1. *Instability*

488. Instability in micro and small businesses may mean that some have good potential to upgrade national innovative performance and function as cradles of innovators, while some lack resources and support for any innovation. Macro level uncertainty limits any long-term innovation activity.

2.2.2. *Informality*

489. Developing countries' economies rely significantly on informal practice. Informality is not a favourable context for innovation. The sometimes great creativity invested in solving problems in the informal economy does not lead to systematic application and thus tends to result in isolated actions which neither increase capabilities nor help establish an innovation-based development path.

2.2.3. *Particular economic and innovation environments*

490. Many enterprises in developing countries operate in unusual economic and innovation environments owing to the existence, and in some cases prevalence, of state-owned enterprises (China) or massive parastatal enterprises (some Arab states), where a lack of competition sometimes discourages innovation or drains local markets of innovative potential., although big state-owned enterprises (for example in sectors such as oil, aerospace or telecommunications) sometimes become technological leaders through important investments in experimental development work (as in some Latin American countries). Moreover, in countries with less developed economic systems, major government S&T policies and programmes may have more impact on innovation than the activities and strategies of private enterprises.

491. Past techno-economic paradigms have continuing economic importance in some cases; in others, a paradigm switch is delayed owing to the high costs involved, insufficient supplies of local capital and lack of credit for big technological investments.

492. Local markets in developing countries tend to be small, sometimes as a result of a less developed infrastructure, and this reduces the scope of the enterprise's actions and the relevance of actual innovations ("new to the market" may have a different meaning in such environments).

493. Innovations in the agricultural sector have a high economic impact, owing to the sector's significant overall economic weight.

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2.2.4. Reduced innovation decision-making powers

494. The dominance of externally controlled or multinational corporations results in less decision making by local enterprises or subsidiaries (especially in the area of innovation), mainly because of the division of functions in these organisations. In the last few years, this division has even been extended to independent local enterprises in the framework of international manufacturing networks. Technology transfer from multinational corporations and from abroad is therefore a fundamental source of innovation.

2.2.5. Weak innovation systems

495. Fewer resources are devoted to innovation activities system-wide, thereby reducing the innovation potential of enterprises. The government is a major player in R&D execution and funding, mainly owing to a low level of resources devoted to R&D by businesses.

496. Flows of information within national systems of innovation are fragmented, and in some cases there is an absence of linkages between science and enterprises. Weak or absent linkages challenge the capacities of firms to overcome (technology-related) problems and draw firms towards solutions that mostly rely on acquisition of embodied technology.

497. Barriers to accumulation of capabilities by enterprises are high and difficult to tackle, particularly in the case of highly qualified human capital, local and international linkages, and tacit knowledge incorporated in organisational routines.

2.2.6. Characteristics of innovation

498. The acquisition of embodied technology (equipment) for both product and process innovation is a major component of innovation.

499. Minor or incremental changes are the most frequent type of innovation activity in some developing countries, together with innovative applications of existing products or processes.

500. Organisational change is an extremely significant aspect of the innovation process. Besides its direct impact on enterprise performance, it also contributes to the enterprise's ability to absorb new technologies incorporated in machinery and other equipment (the most frequent type of innovation). Heterogeneity frequently prevails with regard to firms' technological, organisational and managerial patterns, with "high-technology" firms coexisting with informal businesses, and with many enterprises lacking a formal organisational structure. This creates a need for organisational change, often independent of product and process innovation.

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3. Innovation measurement in developing countries

501. Innovation measurement in developing countries has to produce results comparable to those obtained in developed countries that use the *Oslo Manual* in order to enable benchmarking and construct a coherent international system of innovation indicators. At the same time, innovation surveys need to respect and be able to pick up the characteristics of innovation in developing countries presented in Section 2. Therefore, the definition of innovation, its subtypes (product, process, marketing and organisational innovation), innovation activities and the innovative firm, as presented in Chapter 3, should be applied in innovations surveys in developing countries.

502. While most of the issues presented in Section 2 are addressed below, some continue to present problems from the measurement point of view. This is mainly due to the difficulty of applying existing definitions. One of the main issues, also mentioned in Section 5, is the problem of measuring incremental changes, which may not result in "new or significantly improved" products or processes. Another pending issue is related to the scope of innovations, since concepts such as "new to the market" may have different interpretations in environments with less developed infrastructure.

3.1. *Specific needs for public policy and private strategies: the potentially innovative firms*

503. Innovation surveys in developing countries need to be based on methods and procedures that take into account the aspects mentioned in Section 1 in order to become useful instruments for public and private decision making. In developing countries, the main reason for conducting innovation surveys is to inform public policy making and the design of business strategies, with the main focus on the generation, diffusion, appropriation and use of new knowledge in businesses. Less priority is given to cross-country comparisons and benchmarking.

504. Measurement exercises should therefore focus on the innovation process rather than its outputs and emphasise how capabilities, efforts and results are dealt with. The efforts made by firms and organisations (innovation activities) and capabilities (stocks and flows) are, for this reason, equally or even more important to determine and analyse than the results (innovations). Factors hampering or facilitating innovation are seen as key indicators in this context.

505. A particular subject of interest in developing countries is the "potentially innovative firm". Innovation-active firms are those "that have had innovation activities during the period under review, including those with ongoing and abandoned activities". Potentially innovative firms are a subset of these, those that have made innovation efforts (*i.e.* conducted innovation

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activities) but have not achieved results (innovations) during the period of analysis.

506. Inside this group, might be found businesses that have innovated in the past, or businesses that may innovate in the near future. Nevertheless, considering that products and processes become obsolete rapidly, the existence of a large number of potentially innovative enterprises may suggest strong barriers to innovation, or premature attempts to innovate in the absence of the necessary resources. A key element in innovation policies in developing countries is to assist potentially innovative firms to overcome the obstacles that prevent them from being innovative and to convert their efforts into innovations.

3.2. Measurement priorities

507. **Measurement priorities in developing countries have to take into account different responses to common questions (*why do we measure innovation, what should we measure, and how should we measure*), which result in different priorities when designing an innovation survey.** The first question refers to the aims or the main functions of these surveys. The second and third help to clarify the object to be measured and the most suitable methods and procedures. The third question is closely related or even derived from the first.

508. In developing countries, the responses sought from innovation surveys are less the number of innovative enterprises, or even innovation counts, than information that will allow public and private stakeholders to analyse the various **innovation strategies** present in the innovation system under scrutiny, and to evaluate and understand how these patterns contribute to strengthening the competitiveness of particular enterprises and more generally to economic and social development. These data also allow for the construction of different models of technological behaviour followed by enterprises.

509. This approach requires linking the analysis of micro, meso and macroeconomic levels; relating innovation data to the technological content of exports; studying strengths and weaknesses of particular industries or innovation systems in general; assessing the absorption capacity of innovation systems; identifying networks; exploring the relationship between the formal education system and employment; and obtaining indications about the effectiveness of different public instruments for supporting and promoting innovation.

510. In order to construct indicators of potentially innovative firms, measurement instruments need to take account of all enterprises (*i.e.* both innovative and non-innovative), particularly when addressing the main issues

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related to **innovation strategies**, such as **innovation activities**, **obstacles**, **capabilities**, **linkages** and **results**.

3.2.1. *Innovation capabilities*

511. Innovation capabilities are extremely helpful for classifying firms and industrial sectors in developing countries. A firm's capabilities are what mainly allow it to take advantage of market opportunities. The most significant innovation capability is the knowledge accumulated by the firm, which is mainly embedded in human resources, but is also in procedures, routines and other characteristics of the firm. **Innovation capabilities**, as well as technological capabilities, are the result of learning processes, which are conscious and purposeful, costly and time-consuming, non-linear and path-dependent and cumulative. Because of the **interactive**, **technology-specific** and **culturally influenced nature** of trajectories, a range of possible development paths exists, particularly in developing countries where innovativeness and entrepreneurship may be infrequent and possess particular characteristics.

512. Knowledge about innovation capabilities and the firm's efforts to increase these are key to understanding its present and future performance. Innovation capabilities condition the design of strategies to introduce changes, improvements and/or innovations (**innovation strategies**). If innovation strategies are at the heart of policy interest, innovation capabilities are the most important issue for the design of an innovation survey in developing countries.

513. Many difficulties are involved in measuring innovation capabilities, since it is necessary to measure knowledge that is not codified, but "stored" in individuals' minds or organisational routines. At the same time, it is not easy to obtain reliable data from firms about the exchange of knowledge with other agents or organisations.

514. The priority given in developing countries to measuring **innovation capabilities** motivates placing additional emphasis on certain aspects of surveys:

- Human resources.
- Linkages.
- Information and communication technologies (ICTs), their incorporation and use.

515. There is also an increased need to examine more complex issues such as the types of decision-making support systems put in place by the firm's direction and management, as well as the firm's actual potential for knowledge absorption.

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3.2.2. Expenditure on innovation activities

516. In order to measure firms' **innovation efforts** appropriately, it is essential to understand the intensity of innovation activities carried out. It is therefore recommended to obtain more details about which innovation activities were undertaken by the firm in the reference period and, where deemed feasible, to collect data on expenditure by innovation activity, as indicated in Chapter 6. This indicator serves as a powerful discriminator of firms' behaviour and strategies. In order to explain firm development, innovation expenditure needs to be complemented by more general information on the development of the sector of economic activity in which the firm is active. This information can be obtained through innovation surveys if it is not readily available through other sources at national statistics offices.

3.2.3. Organisational innovation

517. The absorption of new technologies, mostly incorporated in machinery and other equipment, can require significant **organisational change** for many enterprises in developing countries. Since innovation in developing countries has a strong component of absorption of technologies generated in industrialised countries, organisational change acquires substantive relevance. The enterprise's behaviour in this field therefore becomes important for explaining differences in performance and competitiveness.[4]

518. In order to gain additional information on the innovative capabilities of enterprises in developing countries, questions on the implementation of organisational innovations can be supplemented by questions on human resources and training and the incorporation of ICTs. Both would help to provide an indication of an enterprise's innovative capabilities.

4. Principal adaptations

519. Three main topics might be taken into account in adapting innovation surveys for developing countries: ICTs, linkages and innovation activities.

4.1. ICTs in innovation surveys

520. The role of ICTs in innovation is related both to "front-office" and "back-office" applications (see Box A.1). In developing countries, the incorporation of ICTs in enterprises has frequently been limited to sophisticated "front-office" applications (such as Web page, call centre, e-mail or digital brochures and catalogues). However, it is considered that the main impact on the enterprise's performance can be obtained by implementing ICTs to support or automate critical activities or processes ("back-office").

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Box A.1. **"Front office" *vs.* "back office"**

Front-office applications include those focused on sales and marketing, customer self service, Web portals and call centres. The common thread is a high level of employee or customer interaction.

A back-office is a part of most corporations and carries out tasks needed for the running of the company itself. Back-office activities are an organisation's internal operations that support core processes and are not accessible or visible to the general public. Back-office applications support or automate critical activities or processes.

Thus, innovation surveys in developing countries should focus on **the use of ICTs**, which is a powerful tool for differentiating situations, since even medium and large firms frequently do not have a consolidated management system, the lack of which constitutes a serious obstacle to achieving better performance in the various areas of the business.

521. This analysis of the "deeper" dimensions of ICT implementation in firms would help to expose the differences between enterprise characteristics in developing and in industrialised countries, especially in the medium-income developing countries where the difference may not be evident when analysing only the more "superficial" front-office ICTs. It is still not possible to carry out a definitive statistical analysis of the relation between deeper and more complex integration of ICTs and business performance in developing countries. However, partial evidence and case studies have shown the potential for further research, particularly through innovation surveys. Further evidence will help to clarify the relationship between ICTs and innovation, complementing the more readily available literature on ICT and productivity.

522. Taking into account the fact that questionnaires should be as short and simple as possible, in cases where no specific surveys on ICTs in businesses are available, innovation surveys should enquire about available infrastructure; use of ICTs (separating front- and back-office activities) and the ultimate purpose of ICT usage; existence of internal ICT management and development capabilities; ICT expenditure and its relationship with organisational innovation.

4.2. Linkages

523. Following the recommendations in Chapter 5, emphasis should be put on measuring linkages. In order to enable the weighting of the firm's different linkages, a proxy measure of complexity can be developed by crossing "type" and "objective" of the linkages. This can be done by establishing **a matrix of**

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linkage agents (*i.e.* universities, technical and vocational training institutions, technological centres, test labs, suppliers, clients, head office, enterprises belonging to the same group, other firms, consultants, R&D firms, public S&T agencies), **and types of linkage** (including open information sources, acquisition of knowledge and technology, and innovation co-operation, *supplemented by complementary activities, particularly access to new sources of financing and to commercial information*).

524. The innovation success of developed countries is related to the fact that they offer regional environments in which firms can reach the knowledge sources they need, combined with broad access to leading global knowledge bases. Firms in developing countries most frequently do not have access to high-end knowledge, and therefore the local environment is very important for them. Consequently, **it is recommended to include questions on the geographical location of linkages**. One possible breakdown is local, regional, national and international locations.

4.3. Innovation activities

525. The need to focus on the activities and capabilities of firms leads to more attention to some specific innovation activities, as classified in Chapter 6. In order to comply with the priority criteria presented, it is recommended to include activities such as:

- "Hardware purchase", and "Software purchase" (separately, not just included in "Acquisition of machinery, equipment and other capital goods").
- "Industrial design", and "Engineering activities" (separately, not just included in "Other product and process development").
- "Lease or rental of machinery, equipment and other capital goods".
- "In-house software system development".
- "Reverse engineering".

4.4. Additional adaptations

526. It is recommended to collect data on human resources, from the perspective of both its composition (by qualification, type of occupation – see Chapter 6 – and gender) and its management. From the point of view of human resource management, it is particularly important to collect information on actions taken by firms with regard to training, including the resources involved. In order to obtain information on the innovative capabilities of enterprises, data can be collected not only on training activities that are linked to innovation, but also on general training in areas such as management and administrative training, ICT, industrial security and quality control.

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5. Methodological issues for developing country contexts

5.1. *Information system specificities*

527. The design and planning of innovation surveys in developing countries needs to take into account the **relative weakness of statistical systems**. Linkages between surveys and data sets tend to be weak or nonexistent, preventing the use of information from other surveys both in the design of the exercise and in the analysis of its results. The weakness, or sometimes lack, of official business registers, which are normally used as sample frames, is another example of this type of problem.

528. It is particularly important to involve national statistics offices (NSOs) in innovation surveys, even if such surveys do not constitute a high priority in the national statistical programmes of some developing countries. Involvement of NSOs may sometimes include the signing of formal agreements between the various institutions (which frequently include government departments and universities). The participation of NSOs in innovation surveys brings to the table experience in the design and application of surveys and allows the resolution of problems in registers and other background information. It also helps to obtain higher response rates, and raises the possibility of making the survey compulsory. Moreover, if the sample used is the same as for other economic surveys, it presents the possibility of wider-ranging analysis.

529. Statistical systems in developing countries frequently lack the necessary information about firm performance (such as data on sales, investments, exports), only have outdated data or cannot provide data in a suitable form for statistical analysis. In such cases, a number of basic variables can be included in the innovation survey in order to enable analysis of the relationship between actions taken by firms for innovation and market performance (competitiveness). However, a tension between the need for extra questions and the response burden exists. In order to maximise response rates and improve coverage, a balance should be sought, taking into account that operational simplicity and fluidity may be detrimental to the analytical potential of the exercise.

5.2. *General methodological considerations*

5.2.1. Application of the survey

530. Interviews made in person (instead of surveys by mail or by phone) and by adequately trained staff (for instance, undergraduate or graduate students) are recommended, since they have proved to have a positive impact on the response rate and on the quality of the results obtained.[5] This is particularly important in developing country contexts where postal services may not be

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reliable. Moreover, interviews conducted by qualified staff provide the respondent with immediate and relevant assistance in completing the questionnaire, thereby improving the quality of the results.

5.2.2. *Questionnaire design*

531. The questionnaire can be designed so that the sections can be separated to allow different persons in the firm to reply to different sections. This is particularly valid for questions relating to the firm's general economic data, which may be provided by the finance division, or specific questions about the innovation process, which may be completed by the product or plant manager. This may result in more reliable information.[6] It is nevertheless important to avoid delaying the survey or losing a partially completed questionnaire because of this strategy.

532. It is also advisable to include guidance in the main questionnaire, in order to help the respondent understand and avoid losing the instructions. It is important to recognise that in some developing countries respondents may not understand the concept of "innovation" or even the word. If this may be the case, questions must include definitions.

533. Special attention has to be given to the language in which the questionnaire is written. The wording needs to be adapted to meet the knowledge and experience of an "average" respondent. In some cases, it may be necessary to present questionnaires in more than one language to help respondents.[7]

5.2.3. *Frequency and other recommendations*

534. While Chapter 8 of the Manual recommends conducting innovation surveys every two years, it is recognised that in developing country contexts the periodicity should be every three or four years. If possible, the innovation surveys should be timed to coincide with the major international innovation surveys, such as the Community Innovation Survey (CIS) rounds in Europe, in order to obtain comparable data for similar time periods. It is also convenient to update a minimum set of variables every year (the main quantitative ones, for example), if resources permit. A less costly strategy is to attach a significantly reduced questionnaire to an existing business survey.

535. The results of the innovation surveys should be published and distributed widely, in order to encourage further participation by businesses in future rounds and to increase awareness and use by researchers and policy makers. Diffusion mechanisms need to be included in the budget early in the exercise.

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536. A frequent difficulty in obtaining reliable information on innovation in countries with a less developed statistical tradition is business's lack of appreciation of the importance of innovation and the relevant public policy instruments. Managers are frequently secretive about finance, and qualitative information is sometimes more reliable than quantitative information. The purpose of surveys needs to be clearly stated and the questions clearly formulated. Under these circumstances, an adequate legislative base for the collection of innovation statistics can help ensure the success of such an exercise. In some cases, simplified questionnaires can be designed to cover small firms, in order to encourage their participation in innovation surveys.

6. Thinking ahead

537. A number of important questions regarding innovation measurement in developing countries remain unanswered. However, various approaches have been tried out in different countries and deserve further research, involving issues such as:

- The role of entrepreneurs and their attitudes towards innovation.
- The intention to capture innovations driven by factors other than market forces, and in particular innovations conducted by the public sector (Salazar and Holbrook, 2004).
- The adaptation of methodology to measure innovation in the primary sector (particularly in agriculture).
- The development of indicators reflecting sub-national (regional) innovation systems.

538. The application of the suggestions made here can lead to broader experience with innovation surveys in developing countries. It is expected that some countries with better S&T statistics experience will soon go beyond conducting R&D surveys and include innovation surveys in their statistical programmes. The consolidation of standards, concepts, formats and other issues better suited for developing countries, such as those proposed in this annex, should help build awareness and capacity. Further efforts in direct capacity building for innovation surveys will be key to the success of this endeavour.

Notes

1. Lugones and Peirano (2004). This document was based on contributions made as part of the activities of RICYT by a group of Latin American experts (M. B. Baptista (DINACYT-Uruguay), J. E. Cassiolato (IE/UFRJ-Brazil), M. Mainieri (SENACYT-Panama), F. Malaver Rodríguez and M. Vargas Pérez (Comcyt/OCyT-Colombia),

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2. The UIS panel was co-ordinated by Simon Ellis and Ernesto Fernández Polcuch, and included as contributors the authors of the base document (Gustavo Lugones and Fernando Peirano, RICYT); Pierre Tremblay, IDRC, Canada; Gao Changlin, and Jiancheng Guan, China; Javier Revilla Diez, Germany (with experience in Thailand, Singapore and Penang State, Malaysia); Annamária Inzelt, Hungary; Laxman Prasad, India; Antoine Zahlan, Lebanon; Fadzilah Ahmad Din (with Anita Bahari and Dr. Cassey), MASTIC, Malaysia; Anna Ong, Penang State, Malaysia; Michael Kahn (with William Blankley and Simon Mpele) and Tinus Pretorius (with Andre Buys), South Africa; Bitrina Diyamett, Tanzania; and Patarapong Intarakumnerd, Thailand. Valuable comments were received from the OECD Secretariat, as well as various NESTI members (particularly Carter Bloch and Frank Foyn). However, contents of this annex are the sole responsibility of the UNESCO Institute for Statistics and the publishers of the *Oslo Manual*.

3. For example, the first South African innovation survey found, for instance, that 86% of innovations in South African industry are of incremental nature.

4. In the particular case of many Latin American countries, the need for firms to permanently adapt and adjust to recurrent alterations in the economic context reinforces the idea that organisational change is an essential dimension of firms' competitiveness.

5. This was found to be of particular importance in Latin America, and also in Africa, where experience has shown that the response rate to mailed questionnaires is extremely low.

6. The multiple informants approach has proved to increase reliability and validity of the innovation survey in China.

7. In the case of the Thai survey, questions were presented in English and Thai, since it was considered that sometimes people can understand technical terms in English more easily than in their native language.

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ANNEX B

Examples of Innovations

1. Introduction

539. This annex provides a list of examples for each type of innovation. These lists are intended as illustrations and should not by any means be considered exhaustive. They are intended to give survey practitioners a better understanding of each innovation type, but they are not designed to be shown to enterprises as examples of innovations. There are two reasons for this. First, their inclusion might bias firms into excluding innovations that are not on the list. Second, the list is dated, with many innovations impossible to foresee. It is also worthwhile emphasising that two central criteria for innovations are that they represent significant changes and that they are new to the firm. Thus, a change can be an innovation for one firm and not for another. Often, more detailed descriptions are needed to determine whether a change is to be classified as an innovation and of which type.

2. Examples of innovations

540. A **product innovation** is the introduction of a good or service that is new or significantly improved with respect to its characteristics or intended uses. This includes significant improvements in technical specifications, components and materials, incorporated software, user friendliness or other functional characteristics.

541. **Product innovations exclude the following:**

- Minor changes or improvements.
- Routine upgrades.
- Regular seasonal changes (such as for clothing lines).
- Customisation for a single client that does not include significantly different attributes compared to products made for other clients.

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- Design changes that do not alter the function, intended use or technical characteristics of a good or service.
- The simple resale of new goods and services purchased from other enterprises.

542. **Examples of product innovations:**

Goods

- Replacing inputs with materials with improved characteristics (breathable textiles, light but strong composites, environmentally friendly plastics, etc.).
- Global positioning systems (GPS) in transport equipment.
- Cameras in mobile telephones.
- Fastening systems in clothing.
- Household appliances that incorporate software that improves user friendliness or convenience, such as toasters that automatically shut off when the bread is toasted.
- Anti-fraud software that profiles and tracks individual financial transactions.
- Inbuilt wireless networking in laptops.
- Food products with new functional characteristics (margarine that reduces blood cholesterol levels, yoghurts produced using new types of cultures, etc.).
- Products with significantly reduced energy consumption (energy efficient refrigerators, etc.).
- Significant changes in products to meet environmental standards.
- Programmable radiators or thermostats.
- IP (Internet protocol) telephones.
- New medicine with significantly improved effects.

Services

- New services that significantly improve customers' access to goods or services, such as home pick-up and drop-off service for rental cars.
- DVD subscription service where for a monthly fee customers can order a predefined number of DVDs via the Internet with mail delivery to the home, with return via a pre-addressed envelope.
- Video on demand via broadband Internet.
- Internet services such as banking, or bill payment systems.

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- New forms of warranty, such as an extended warranty on new or used goods, or bundling warranties with other services, such as with credit cards, bank accounts or customer loyalty cards.
- New types of loans, for example variable rate loans with a fixed rate ceiling.
- Creation of Web sites on the Internet, where new services such as product information and various support functions can be offered to clients free of charge.
- The introduction of smart cards and multipurpose plastic cards.
- A new, self-service bank office.
- Offering customers a new "supply control system" which allows clients to check that deliveries from contractors meet specifications.

543. A **process innovation** is the implementation of a new or significantly improved production or delivery method. This includes significant changes in techniques, equipment and/or software.

544. **Process innovations exclude the following:**

- Minor changes or improvements.
- An increase in production or service capabilities through the addition of manufacturing or logistical systems which are very similar to those already in use.

545. **Examples of process innovations:**

Production

- Installation of new or improved manufacturing technology, such as automation equipment or real-time sensors that can adjust processes.
- New equipment required for new or improved products.
- Laser cutting tools.
- Automated packaging.
- Computer-assisted product development.
- Digitisation of printing processes.
- Computerised equipment for quality control of production.
- Improved testing equipment for monitoring production.

Delivery and operations

- Portable scanners/computers for registering goods and inventory.
- Introduction of bar coding or passive radio frequency identification (RFID) chips to track materials through the supply chain.
- GPS tracking systems for transport equipment.
- Introduction of software to identify optimal delivery routes.

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- New or improved software or routines for purchasing, accounting or maintenance systems.
- Introduction of electronic clearing systems.
- Introduction of automated voice-response system.
- Introduction of electronic ticketing system.
- New software tools designed to improve supply flows.
- New or significantly improved computer networks.

546. A **marketing innovation** is the implementation of a new marketing method involving significant changes in product design or packaging, product placement, product promotion or pricing.

547. Marketing innovations exclude the following:

- Changes in product design or packaging, product placement, product promotion or pricing that are based on marketing methods that have previously been used by the enterprise.
- Seasonal, regular and other routine changes in marketing instruments.
- The use of already applied marketing methods to target a new geographical market or a new market segment (*e.g.* socio-demographic group of clients).

548. **Examples of marketing innovations:**

- Marketing innovations can refer to any marketing method (product design/packaging, placement, pricing, promotion) as long as it is used for the first time by the firm.

Design and packaging

- Implementation of a significant change in the design of a furniture line to give it a new look and widen its appeal.
- Implementation of a fundamentally new design of bottles for a body lotion intended to give the product a distinctively exclusive look.

Placement (sales channels)

- First-time introduction of product licensing.
- First-time introduction of direct selling or exclusive retailing.
- Implementation of a new concept for product presentation such as sales rooms for furniture that are designed according to themes, allowing customers to view products in fully decorated rooms.
- Implementation of a personalised information system, *e.g.* obtained from loyalty cards, to tailor the presentation of products to the specific needs of individual customers.

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Pricing

- Introduction of a new method that allows customers to choose desired product specifications on the firm's Web site and then see the price for the specified product.
- First-time use of a method for varying the price of a good or service according to demand for it.
- First-time use of in-store special offers that are only accessible to holders of the store's credit card or reward card.

Promotion

- First-time use of trademarks.
- First-time use of product placement in movies or television programmes.
- Introduction of a fundamentally new brand symbol intended to position the firm's product on a new market.
- First-time use of product seeding through opinion leaders, celebrities or particular groups that are fashion or product trend setters.

549. An **organisational innovation** is the implementation of a new organisational method in the firm's business practices, workplace organisation or external relations.

550. Organisational innovations exclude the following:

- Changes in business practices, workplace organisation or external relations that are based on organisational methods already in use in the firm
- Changes in management strategy, unless accompanied by the introduction of a new organisational method
- Mergers with, and the acquisition of other firms

551. **Examples of organisational innovations:**

- Organisational innovations can refer to any organisational method in a firm's business practices, workplace organisation or external relations as long as it is used for the first time by the firm.

Business practices

- Establishing of a new database of best practices, lessons and other knowledge so that they are more easily accessible to others.
- First-time introduction of an integrated monitoring system for firm activities (production, finance, strategy, marketing).
- First-time introduction of management systems for general production or supply operations, such as supply chain management, business re-engineering, lean production, quality management system.

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- First-time introduction of training programmes to create efficient and functional teams that integrate staff from different backgrounds or areas of responsibility.

Workplace organisation

- First-time implementation of decentralised job responsibility for the firm's workers, such as giving substantially more control and responsibility over work processes to production, distribution or sales staff.
- First-time establishment of formal or informal work teams to improve the access and sharing of knowledge from different departments, such as marketing, research and production.
- First-time implementation of an anonymous incident reporting system to encourage the reporting of errors or hazards in order to identify their causes and reduce their frequency.

External relations

- First-time introduction of quality control standards for suppliers and subcontractors.
- First-time use of outsourcing of research or production.
- First-time entering into research collaboration with universities or other research organisations.

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Acronyms

CA	Controlled affiliate
CAPI	Computer-assisted personal interview
CATI	Computer-assisted telephone interview
CEC	Commission of the European Communities
CIS	Community Innovation Survey
EEC	European Economic Community
EU	European Union
GPS	Global Positioning System
ICT	Information and communication technology
INSEE	Institut National de la Statistique et des Études Économiques
IP	Internet protocol
IPRs	Intellectual property rights
ISCED	International Standard Classification of Education
ISIC	International Standard Industrial Classification of Economic Activities
KAU	Kind of activity unit
LBIO	Literature-based indicators of innovation output
LMTs	Low- and medium-technology industries
MNE	Multinational enterprise
NACE	*Nomenclature statistique des Activités économiques de la Communauté Européenne* (Statistical Classification of Economic Activities in the European Community)
NSO	National statistical office
PPS	Probabilities proportional to size
R&D	Research and development
RFID	Radio frequency identification
RICYT	*Red Iberoamericana de Indicadores de Cienca y Tecnología* (Ibero-American Network on Science and Technology Indicators)
S&T	Science and technology
SNA	System of National Accounts
TPP	Technological product and process
UIS	UNESCO Institute for Statistics

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