Characterization of the Innovation Process in Collaborative R&D Projects in Portugal

The Case of 49 Product Development Innovation Projects Undertaken by University-Enterprise Consortia in Portugal
Characterization of the Innovation Process in Collaborative R&D Projects in Portugal

The Case of 49 Product Development Innovation Projects Undertaken by University-Enterprise Consortia in Portugal

Claudia-Melania Chituc

Porto, May 2004
Characterization of the Innovation Process in Collaborative R&D Projects in Portugal

The Case of 49 Product Development Innovation Projects Undertaken by University-Enterprise Consortia in Portugal

M.Sc. Thesis in Electrical and Computer Engineering
Area of Specialization: Information Technology for Enterprise Management

Claudia-Melania Chituc
Porto, May 2004
Characterization of the Innovation Process in Collaborative R&D Projects in Portugal

The Case of 49 Product Development Innovation Projects Undertaken by University-Enterprise Consortia in Portugal

Thesis submitted at the Faculty of Engineering of the University of Porto in order to obtain the M.Sc. Degree in Electrical and Computer Engineering (Area of specialization: Information Technology for Enterprise Management).

The Thesis was made under the supervision of:
Prof. José Manuel Mendonça - Full Professor of DEEC/FEUP
Abstract

The crucial importance of innovation for economic growth and sustainable development is undisputed. The success of individual innovation projects relies on a number of factors, some of which are often neglected when analysing the innovation process, such as strategic alliances and partnerships, consortia structure, IPR protection, exploitation strategies for the project results, etc.

This Thesis focuses on the analyses and characterization of the innovation process in product development projects undertaken by consortia formed by companies and research centres in Portugal. The methodology developed is described and the results which are part of the outcome of an empiric research study conducted by INESC Porto and the Science and Higher Education Observatory (OCES) of the Portuguese Ministry of Science and Higher Education (MCES), are presented and discussed.
Resumo

A importância crucial da inovação para o crescimento económico e o desenvolvimento sustentável está fora de discussão. O sucesso de projectos individuais de inovação baseia-se num número de factores, alguns dos quais são frequentemente negligenciados ao analisar o processo da inovação, tal como associações estratégicas e parcerias, estrutura dos consórcios, proteção dos direitos de propriedade intelectual, estratégias da exploração dos resultados do projeto, etc..

Este dissertação focaliza a sua atenção na análise e na caracterização do processo da inovação nos projectos de desenvolvimento de produto empreendidos por consórcios formados por empresas e por centros de investigação em Portugal. A metodologia desenvolvida é descrita e os resultados que são parte do resultado de um estudo empírico de investigação conduzido pelo INESC Porto e pelo Observatório da Ciência e do Ensino Superior (OCES) do Ministério da Ciência e do Ensino Superior (MCES), são apresentados e discutidos.
Rezumat

Importanta cruciara a procesului de inovare pentru cresterea economica si dezvoltare este indiscutabila. Sucesul proiectelor de inovatie individuale depinde de numerosi factori, unii dintre aceastia deseori fiind neglijati atunci cand se analizeaza procesul de inovare, precum aliantele strategice si parteneriatele, structura unui consortiu, protejarea drepturilor de proprietate intelectuala, strategiile de exploatare a rezultatelor proiectului, etc.

Aceasta teza se concentreaza asupra analizei si caracterizarii procesului de inovare in proiecte de dezvoltare de produse realizate in consortii formate din intreprinderi si centre de cercetare in Portugalia. Este descrisa metodologia aplicata si sunt prezentate si comentate rezultatele, care au fost obtinute in urma unui studiu de cercetare experimental consude de INESC Porto si Observatorul de Stiinta si Educatie Superioara (OCES) al Ministerului Portughez de Stiinta si Educatie Superioara (MCES).
Résumé

L’importance cruciale de l’innovation pour la croissance économique et le développement durable est indiscutable. Le succès de projets d’innovation individuelle repose sur un nombre de facteurs, parmi lesquels certains sont souvent négligés lorsque l’on analyse le processus d’innovation, tels que les alliances stratégiques et les partenariats, la structure de consortiums, la protection des droits de la propriété intellectuelle, les stratégies d’exploitation des résultats du projet, etc.

Cette thèse se concentre sur l’analyse et la caractérisation du processus d’innovation dans des projets de développement de produits entrepris par des consortiums composés de compagnies et de centres de recherche au Portugal. La méthodologie développée est décrite et les résultats, qui font partie des conclusions d’une étude de recherche empirique conduite par l’INESC de Porto et l’Observatoire des Sciences et de l’Education Supérieur (OCES) du Ministère Portugais de la Science et de l’Education Supérieur (MCES), sont présentés et discutés.
Resumen

La importancia crucial de la innovación en el crecimiento económico y el desarrollo sostenido es indiscutible. El éxito de los proyectos individuales de innovación reside en diversos factores, algunos de los cuales no son tenidos en cuenta cuando se analiza el proceso de innovación en cuestión, tales como alianzas y asociaciones estratégicas, estructuras de consorcio, protección de los derechos de propiedad intelectual, estrategias de explotación para los resultados del proyecto, etc.

Esta tesis se centra en el análisis y caracterización de los procesos de innovación en proyectos de desarrollo de productos llevados por el consorcio formado por compañías y centros de investigación en Portugal. Se describe la metodología desarrollada y se presentan y discuten los resultados que forman parte de un estudio experimental llevado a cabo por el INESC Porto y el Observatorio de Ciencia y Enseñanza Superior (OCES) del Ministerio de Ciencia y Enseñanza Superior (MCES) de Portugal.
บทคัดย่อ

สรุปผลรวมใหม่ ๆ ที่เกิดขึ้น รวมไปถึงการพัฒนาด้านต่าง ๆ ที่มีส่วนช่วยผลักดันให้เกิดสิ่งใหม่ ๆ
ได้เข้ามาเป็นบทบาทอย่างเร่งด่วนไม่ได้ในปัจจุบัน ปัจจัยหลาย ๆ อย่าง
ที่ก่อให้เงื่อนไขรัฐธรรมนูญสามารถทำได้ มีอยู่ในสัดส่วนของข้อกำหนดของ
การประสานทางสิทธิบัตร กลุ่มที่ต่าง ๆ ของการแสดงภาพผลประโยชน์ และอื่น ๆ

จุดมุ่งหมายของวิทยาศาสตร์ กีฬาวิเคราะห์

และแสดงลักษณะผลที่ดีที่สุดของกระบวนการรัฐบาลในโครงการต่าง ๆ
ที่เกี่ยวข้องกับการพัฒนาผลิตภัณฑ์ ภายใต้การรวมมือระหว่างบริษัท และสุนัขวิจัยต่าง ๆ
ในประเทศโปรตุเกส ขึ้นตอนแบบแผนที่ถูกพัฒนาขึ้น รวมทั้งผลของข้อมูลต่าง ๆ
ที่เป็นประโยชน์ได้ถูกจัดทำไว้ โดยวิทยาศาสตร์ฉบับนี้ เป็นส่วนหนึ่งของการศึกษา
และวิจัยจาก INESC Porto และ การสำรวจทางวิทยาศาสตร์และการศึกษา (Science and
Higher Education Observatory, OCES) ของกระทรวงวิทยาศาสตร์ และการศึกษา
(Portuguese Ministry of Science and Hiher Education, MCES)

ของประเทศโปรตุเกส
Preface

This Master's thesis has been carried out in the department of Electrical Engineering and Computers of the Faculty of Engineering of the University of Porto and INESC Porto.

It completes my studies to obtain an M.Sc. in Electrical and Computer Engineering – specialization in Information Technology for Enterprise Management.

The aim of this thesis has been to characterize the innovation process in consortia in Portugal.

Innovation projects undertaken by consortia of enterprises and R&D centres and the relation between successful innovation and strategic alliances or partnerships between companies and academia are not completely new issues. Nevertheless, there are few theoretical contributions and empirically tested framework explaining the relation between the strategic alliances embedded in a consortium and the innovation project's success is not yet available. Undertaking this research and writing this thesis has therefore been a truly challenging and highly creative exercise. We hope that the results of the work may prove useful for the sponsoring entities, INESC Porto and OCES, as well as for other players in the area of innovation. We also hope that they may be a source of inspiration for anyone who wishes to dive deeper into this field in the future.
Dedication

To my parents
Acknowledgements

I followed the path of this degree and it would not have been possible without the aid and support of some persons and institutions to which I would like to thank and show my appreciation. It will be impossible to mention everybody, but I would like to thank especially:

To Prof. José Manuel Mendonça (DEEC/FEUP) - the supervisor of the M.Sc. Thesis. Since I met Prof. Mendonça, he has been a wonderful mentor and friend. For his excellent directional style, extremely valuable discussions and advices preparing me for future challenges, for sharing his experience and sharp-eyed views within the field, I am deeply grateful to him. His high standards and commitment to rigour made me wish to achieve more. For me, he is, and has been throughout our work, an example of determination and professionalism, a source of wisdom and inspiration. He gave me the opportunity to discuss the difficult parts of our works (Thesis and articles); while supporting my views, he graciously introduced me to many exciting new ideas. With patience, utmost precision and attention, he read and reread every single page, every single sentence, and every single word of this Thesis and of all our papers. When I felt I had enough, he inspired me to continue; when I was quite satisfied with some of the texts, he provided me effective, but constructive criticism.

I am extremely fortunate and grateful to have enjoyed the benefits of his brilliance. I hope our works do sufficient credit to his tremendous investment.

For his constant advices, clear guidelines, strong involvement throughout this process which made this work possible (especially for the initiative in forming the ideas of the research study), and for his exemplary professionalism and stability, I am extremely grateful to Mr. Eng. José Carlos Caldeira (INESC Porto). Apart for providing me an excellent professional direction, his friendship proven invaluable.

I am very much indebted to him especially for introducing me to this area, and for believing in me when I just arrived in Portugal.

I particularly wish to express my great appreciation and thank to Prof. Francisco Oliveira Restivo for all his constant kind professional and personal advices, guidelines and support shown since my arrival in Portugal.

For all his friendly and generous advices, recommendations and support, I am indeed grateful to Prof. Raul Vidal.

I extend my special thank to all my Professors from the first year of studies of the Master Course, who have been truly supportive to me: Prof. José Manuel Mendonça, Prof. Américo Azevedo, Prof. Raul Vidal, Prof. Jorge Pinho Sousa, Prof. João José Ferreira, Prof. António Lucas Soares, Prof. Rui Camacho, Prof. Josão Pascoal Faria, Prof. José António Faria and Prof. António Pessoa Maghães.

To INESC Porto for the support and the facilities offered, enabling me to accomplish this work. I am grateful to Mr. Luís Carneiro, the head of the Production Systems and Engineering Unit (UESP), for providing me an excellent working environment.

I benefited here from the warmth and kindness of Mrs. Ana Isabel who has been extremely helpful to me, despite my early terrible broken Portuguese.
To all the persons from UESP involved in the survey design, implementation and data collection: Mr. António Alves, Ms. Paula Silva, Ms. Andreia Sousa and Ms. Marta Tavares.

To the Observatório da Ciência e do Ensino Superior (OCES) of the Ministério da Ciência e do Ensino Superior (MCES) for the encouragement and financial support. A special acknowledgement is due to Dr. Lino Fernandes for his expert advice in the area.

To all my friends from BEST Porto student association (Board of European Students of Technology – Local Group Porto) for their friendship and support making me feel from my first day in Portugal that they are my family.
To my friends from LBG Lisbon who always supported and helped me, Local BEST Groups Almada and Coimbra.

To all the friends that I made during my stay in Portugal, mostly PhD and M.Sc. students from all over the world and especially to Wancheng (Thailand).

To all my colleagues from the M.Sc. course for their friendship, especially to Teresa.

My warmest and greatest gratitude, though, is to my parents – my best friends. For their effort, continuous care, understanding and immeasurable support shown to my brother and I throughout the years.
# Table of Contents

Abstract
Resumo
Rezumat
Résumé
Resumen

Preface
Dedication
Acknowledgements

Table of Contents
List of Figures
List of Tables

## Chapter 1. Introduction

1.1. The Topic of the Thesis .......................................................... 2
1.2. Scope of the Work ..................................................................... 2
1.3. Outline of the Thesis ................................................................. 3

## Chapter 2. Innovation – Basic Concepts ............................................. 4

2.1. Introduction ............................................................................. 4
2.2. Introduction to the Concept on Innovation ................................. 4
2.3. Innovation Model Development ................................................. 6
   2.3.1. Linear Innovation Models .................................................. 6
   2.3.2. Non-linear Innovation Models ............................................ 8
   2.3.3. National and Regional Innovation Systems ....................... 13
2.4. Innovation Analysis-Background Issues .................................... 14
   2.4.1. Data Collection Methods ................................................... 14
   2.4.2. Selected Studies on Innovation Characterization ............... 17
2.5. Innovation in Portugal ............................................................... 20
   2.5.1. Background Elements ...................................................... 20
       2.5.1.1. Science, Technology and Innovation Policies in
               Portugal: Brief Overview ............................................. 20
   2.5.2. Studies on Innovation ...................................................... 28
       2.5.2.1. The Portuguese Community Innovation Survey .......... 28
       2.5.2.2. The European Innovation Scoreboard for Portugal ....... 31

## Chapter 3. The Research Project ..................................................... 34

3.1. Introduction ............................................................................. 34
3.2. Methodological Framing ......................................................... 34
3.3. Definition Phase ..................................................................... 35
3.4. Design and Implementation Phase ............................................ 38
List of Figures

2.1. Innovation process: demand, offer and mediation
2.2. The Linear Model of Innovation
2.3. Kline’s and Rosenberg’s Non-Linear Model of Innovation
2.4. Mayer’s and Rosenbloom’s Non-Linear Model of Innovation
2.5. An Open System Model of Innovation
2.6. Current Portuguese Positioning in the EU against the results of CIS II
2.7. Summary Innovation Index
2.9. Innovation Trend for Portugal

3.1. Generic Model: actors and functions
3.2. Main Operational process of survey data management

4.1. Project’s objectives
4.2. Distribution of functions per entity type
4.3. Adequacy of entities functions – university as project coordinator (1 project)
4.4. Adequacy of entities functions – enterprises as project coordinator (34 projects)
4.5. Adequacy of entities functions – technological centres as project coordinator (6 projects)
4.6. Adequacy of entities functions – R&D institutes as project coordinator (8 projects)
4.7. Level of adequacy of each entity to perform each of the project functions (“Fitness for function”)
4.8. Roles performed by each entity type
4.9. Type of novel products obtained
4.10. Projects’ results introduction on the market
4.11. Reasons for not patenting project’s results
4.12. Project results’ introduction on the market
4.13. Reasons for not reaching exploitation of results
4.14. Entities exploiting project results
4.15. Ratio of successful projects having a determined consortium composition
4.16. Relation between project coordinator’s education level and commercial impact of project results
4.17. Relation between the existence of previous collaboration of the consortium members and the commercial impact of project results
4.18. Relation between setting an exploitation agreement and the commercial impact of project results
4.19. Relation between the consortium members’ performing technology vendor role previous experience in the sectors where the project results are applied and their commercial impact
4.20. Relation between private funding, per project and commercial impact of project results (funding segmentation based as in the public financing programs)
4.21. Relation between enterprises’ private funding, per project and the commercial impact of project results (funding segmentation based as in the public financing programs)
4.22. Relation between private funding, per project and commercial impact of project results
4.23. Relation between enterprises’ private funding, per project and commercial impact of project results
4.24. Relation between funding program and the commercial impact of project results
4.25. Relation between scientific results and commercial impact of project results
5.1. PDIP as system
5.2. Proposed modelling framework for product development innovation projects

B.1. National System of Governance of Innovation Policy
E.1. Functions performed by consortia entities (high and medium level of involvement)
E.2. Functions performed by consortia entities (with high level of involvement)
List of Tables

2.1. Summary of some innovation models characteristics
2.2. Survey types by mode of administration and data capture instrument
2.3. Taxonomy of computer assisted interviewing methods

4.1. Coordinating entities – distribution by entity type
4.2. Project’s starting and ending years
4.3. Portuguese funding programs
4.4. Funding by national funding program
4.5. Frequency of partners per consortia
4.6. Consortium partners’ previous collaboration
4.7. Distribution of (legally distinct) entities involved in the projects analysed by type
4.8. Distribution of all entities involved in the projects analysed
4.9. Distribution of the distinct entities involved in the projects analysed according to the activity sector
4.10. Entity size regarding human resources
4.11. Enterprise size regarding human resources
4.12. Education level per entity type
4.13. Project coordinator’s education level (number and percentage)
4.14. Project coordinator’s position within the coordinating entity
4.15. Engagement in project creation per type of entity
4.16. Distribution of entities involved in similar projects (number and percentage)
4.17. Total number of functions performed, per entity type
4.18. “Fitness of the functions” or level of adequacy of the entity types to the various PDIP functions
4.19. Total and average number of functions performed per entity type
4.20. Consortium members’ previous experience in innovation projects
4.21. Consortium members’ previous experience in innovation projects, per entity type
4.22. Enterprises’ R&D department – analysis per activity sector
4.23. Entities with or without R&D department
4.24. Impact on entities performing end-user and entities performing technology vendor role
4.25. Entities acknowledging positive impact on their image on the market
4.26. Creation or reinforcement of internal R&D activities
4.27. Distribution of entities – per entity type – having an institutional reinforcement of the R&D component in the partner organizations
4.28. Improved relation with S&T institutions (number and percentage per entity type)
4.29. Creation of an internal team for the project development
4.30. Project management responsibility assignment – number and percentage, per entity type
4.31. Direct involvement of the board in the management of the project (number and percentage of entities)
4.32. Consortia composition – participating entity type (number and percentage)
4.33. Consortia structure – existing roles (number and percentage)
4.34. Relation between consortium structure – existing roles – and commercial impact of project results (number)
4.35. Relation between consortium structure – existing roles – and commercial impact of project results (percentage)
4.36. Consortium structure with limitations per entity type and commercial impact of project results
4.37. Relation between consortium composition – participating entity types – and commercial impact of project results
4.38. Relation between project coordinator’s education level and commercial impact of project results
4.39. Relation between project coordinator’s education level and his/her previous experience in research or innovation projects (number and percentage)
4.40. Relation between the education level of the project coordinator of the entity performing the technology vendor role and commercial impact of project results
4.41. Relation between R&D institutes’ previous experience in the sector(s) in which the results are applied and the commercial impact of project results
4.42. Relation between private funding, per project and commercial impact of project results (number of projects)
4.43. Relation between enterprises’ private funding, per project and commercial impact of project results
4.44. R&D institutes’ and universities involvement in performing the researcher role and the novelty of project results
4.45. Relation between funding programs and the commercial impact of project results (percentage)
4.46. Consortium composition and project commercial, technological and scientific output (numbers)
4.47. Consortium composition and project results’ innovativeness, target market and spin-offs or new business units created (numbers)
4.48. Consortium composition and project commercial, technological and scientific output (percentage)
4.49. Consortium composition and project results’ innovativeness, target market and spin-offs or new business units created (percentage)

A.2.1. Supporting tables – Introduction and Menu
A.2.2. Supporting tables – Project
A.2.3. Supporting tables – Partners
A.2.4. Supporting tables - Results
C.1. PDIP Indicators
D. PDIP Keywords List
F.1. Key/supporting technology
Chapter 1. Introduction

1.1. The Topic of the Thesis

The crucial importance of innovation for economic growth and sustainable development is undisputed. As a major driving force towards sustainability, successful innovation — "the act of putting into practice a recent invented process, product or idea, with a commercial exploitation purpose" (Schumpeter, 1934) — depends on individual projects or initiatives which are successful if they lead to innovative products, processes or services with impact on the company's market position.

Innovation emerges under many forms and with the contribution of many actors. One of the most powerful collaboration mechanisms for innovation is the association of different enterprises and institutions with different aims and different competences, but symbiotic interests, in the form of a project consortium.

Managing and promoting innovation are multi-disciplinary tasks generally accepted as key activities in contemporary business activities; their success depends on the complex interaction among different players in the economy: universities, R&D institutes, technology centres, enterprises, enterprise associations, industry sector associations, funding entities, and so on (Chituc et alii, 2003).

The success of individual innovation projects relies on a number of factors some of which are often neglected when analysing the innovation process, such as strategic alliances and partnerships, consortia structure, IPR protection, exploitation strategies for the project results, etc.

Strategic alliances emerging in project-based partnerships for innovation may represent a valuable and effective organizational model, creating competitive advantages for the actors involved through joint-ventures, sub-contracted or out-sourced activities. This is specially true also for those small and medium enterprises (SME's) participating in networks sharing R&D expertise or jointly developing new technologies, because they have access to resources, skills and knowledge that are usually well beyond those of a single player. However, according to Bucic and Gudergang (Bucic et alii, 2002), "despite the popularity of alliances, their failure rate has been reported to be as high as 60 percent within the first two years of operation", in a clear indication that there is still a lot of work to be done regarding their creation and management.

Innovation projects undertaken by consortia of enterprises and R&D centres and the relation between successful innovation and strategic alliances or partnerships between companies and academia are not completely new issues. Nevertheless, the theoretical contributions and the empirical research studies in the area are scarce. And a framework explaining the relation between strategic alliances and innovation project's success is not yet available.

Several studies were conducted to analyse and characterize the innovation process. Because of their different aim, most of the studies do not provide relevant and clear information regarding the factors and the conditions that influence the innovation process and thereby the success or failure of individual innovation projects.
The context and the motivation for the present work are now hopefully better understood.

This thesis focuses on the analysis and characterization of the innovation process in product development projects undertaken by consortia formed by industrial companies, research centres and other entities in Portugal. The methodology developed is presented and the results, which represent part of the outcome of an empiric research study conducted by INESC Porto and the Science and Higher Education Observatory (OCES) of the Portuguese Ministry of Science and Higher Education (MCES), are presented and discussed.

A modelling framework describing the internal structure, components, links, etc. of a product development innovation project (PDIP) was derived building of the knowledge that could be gained during the analysis. Such framework can hopefully be used to support a deeper insight in project organization and management.

The PDIPs analysed cover quite well major sectors of the Portuguese economy, from the so-called traditional manufacturing sectors (textiles, garments, shoes and leather articles, cork and wood, metal products) to medium-high-tech sectors (such as printing, chemical products, machines, medical instrumentation, consumer electronics, automotive industry suppliers). Other important sectors, such as construction, commerce (both retail and warehousing), transportation or information technology services were also present.

The R&D institutes, universities and technological centres involved have as main activities research, development and technology transfer in the areas of information technology, telecommunications, energy, electronics, industrial management, health and bio-medical engineering, among others.

The present study places great emphasis on the characterization and analysis of innovation looked at as a key factor for the improvement of overall business performance throughout the value chain. Accordingly, innovation in PDIP’s should primarily help companies in the development of novel products with great market potential.

1.2. Scope of the Work

The motivation of this work has its origins in a joint initiative of the OCES (Observatório das Ciências e do Ensino Superior – Science and Higher Education Observatory – one of the main institutions conducting research studies in the area of innovation and economic growth in Portugal) (OCES, 2004) and INESC Porto (a Portuguese research institute involved in a large number of research and innovation projects) aimed to analyse and characterize the innovation process in collaborative R&D projects.

This thesis will focus on PDIPs undertaken by consortia of enterprises and research institutions, therefore placing a special emphasis on the so-called “science-based innovation”.

The target of the research was a group of 70 projects co-funded by different national funding programs that came to an end between 1996 and 2002. It was possible to collect thorough information only from 50 of these projects; since one of them was found to be essentially focusing on process innovation, the sample actually used consisted in 49 projects. The roles and the functions played by each entity participating in a consortium (universities, research
and development institutions, technological centres, enterprises, enterprise associations) have sought to be related with the different elements that may be considered as the projects results.

The leading partners of such consortia are mainly manufacturing companies and the partnership includes universities, research institutes, technological centres and entrepreneurial associations. The focus of the research was placed in the relation between the strategic alliances established within the consortia and the measurable project’s success. At the outset, the aim was to give an improved understanding of PDIP’s which could eventually lead to answers to questions such as:

**Question 1**
Which are the functions/roles performed by the partners undertaking a PDIP assuming the highest relevance or having the greater impact on its success?

**Question 2**
Which are the most adequate entity types to perform each of such functions or roles?

**Question 3**
Which is the optimal consortium structure and composition in order to maximize the chances of success of a specific PDIP?

Based on the findings and on the possible answers to the above-guiding questions a framework for modelling innovation was sought.

### 1.3. Outline of the Thesis

The present thesis is structured in six chapters.

The first Chapter introduces the research area, the underlying motivation and the context of the work. The topics, scope and structure of the thesis are presented here.

Chapter 2 sets a conceptual background based on the state-of-the-art concepts of innovation and on the review of recent research work on innovation. A very brief characterization of the current status of innovation in Portugal is also presented and some relevant studies on innovation conducted in Portugal portraying Portugal’s position within the European Union are also briefly presented.

Chapter 3 describes the methodology which supports the work undertaken. The main axis of the study are also presented and discussed.

The main results obtained are analysed and discussed in Chapter 4.

Chapter five presents a modelling framework for PDIP description and management.

The sixth and last Chapter contains the conclusions and contributions of the work, as well as a set of recommendations for future work. The references, bibliography and annexes are also available at the end of the work.
Chapter 2. Innovation – Basic Concepts

2.1. Introduction

The aim of this chapter is to briefly present a few concepts regarding innovation which may help setting the background for the present work. The main definitions and innovation models relevant to the scope of the work are introduced. A review of data collection methods is presented, as well as the attempts that were made to characterize and analyse the innovation process.

The current status of innovation in Portugal is also briefly described, taking full advantage of the results of the major studies on innovation undertaken in Portugal.

2.2. Introduction to the Concept of Innovation

Innovation is known as a very complex multi-disciplinary activity calling for a wide range of competences. It is generally recognized as one of the key factors fostering economic growth, and this justifies the studies that have been conducted in the broad area of innovation and the numerous attempts made to define the concept of innovation, as well as to analyse, understand, characterize and measure the innovation process.

The term innovation evolved from the simple concept of innovation in the field of economy to more elaborated concepts like: technological innovation (during the years 1950s-1960s); industrial innovation (during the 70's and 80s); national and regional innovation systems (during the 1990s); knowledge-based innovation.

Schumpeter (Schumpeter, 1934), the economist referred to as the first to integrate innovation in economic studies and who elaborated the trilogy of invention, innovation and diffusion, regards innovation as central to the analysis of the economic process and proposes five types of innovation:

- Introduction of a new product or qualitative change in an existing product
- Process innovation new to an industry
- The opening of a new market
- Development of new sources of supply for raw materials or other inputs
- Changes in industrial organization

The first of these five types is commonly known as “product innovation”, the second as “process innovation”, applied to both manufacturing and business processes, and the last one is regarded as “organizational innovation” as opposing to the so-called “technological innovation”.

The remaining two types regard the so-called transactional environment where companies evolve and are strongly linked to their strategic positioning both in the suppliers and the clients market.
According to Boia, Conceição and Santo (Boia et alii, 2003) while quoting DeBresson (DeBresson, 1996), Schumpeter’s concept of innovation is only an ex-post concept that cannot give rise in the present stage of knowledge to an operational ex-ante theory. Therefore, the ex-post measured observation of innovation has to be replaced by the ex-ante quantification of a proxy indicator: innovative activities.

Schumpeter’s concept of innovation only refers to a few types of innovation, taking into consideration the current status of economic development and the impact of innovation is only referred briefly at the organization level. No reference is made to the importance of the marketed results of innovation activities. This perspective on innovation is unsuitable to the current stage of innovation and economic development, but it represents an important point of reference in the area of innovation.

The OECD Frascati Manual (OECD, 2002) states that innovation “consists of all those scientific, technological, commercial and financial steps necessary for the successful development and marketing of new or improved manufactured products, the commercial use of new or improved processes and equipment or the introduction of a new approach to a social service”.

The OECD Oslo Manual (OECD, 1996), or “Proposed Guidelines for Collecting and Interpreting Technological Innovation Data”, presents a set of guidelines for collecting and interpreting technological innovation data, in order to obtain comparable innovation indicators that can be developed in OECD countries, and it discusses the analytical and policy problems to which these indicators are relevant. Due to its aim, it deals with innovation at the level of the company or enterprise and it focuses on technological product and process innovation.

The Oslo Manual is based on Schumpeter’s definition of innovation, but the emphasis is placed on the first two elements of the definition. Its commonly accepted definition of measurable innovation from a company viewpoint is: “The market introduction of a product (good or service) new or significantly improved or the introduction of new or significantly improved processes, based in new technological developments, new combinations of existing technologies or use of other type of knowledge acquired”.

According to the Oslo Manual, “A technological product innovation is the implementation/commercialisation of a product with improved performance characteristics, such as to deliver objectively new or improved services to the consumer”.

The above presented concepts of innovation are nowadays increasingly present in the daily activities of all the players which are relevant in PDIP’s, even in the cases where people are not aware of their explicit meaning and do not fully understand the relevance and impact of innovation activities.

A more holistic view on the innovation process that captures the interaction of different activities, which could be performed by different economic actors, is presented in Figure 1.1 (Mendonça, 2002).
The innovation arena is the place where different activities regarding innovation demand, offer and mediation actually meet. After an innovation audit, an action plan could be elaborated followed by a benchmarking study or a technological audit. This would call for a technology search activity undertaken by the mediation side, which intermediates the technology offer and technology demand. These actions will have as potential outcomes actions plans and projects for implementation, development or transfer and development.

2.3. Innovation Model Development

Several innovation models have been developed with the objective of explaining the innovation process and supporting its thorough understanding. Such models are now briefly reviewed and discussed.

2.3.1. Linear Innovation Models

The Linear Model of innovation (Figure 2.2.) presents the innovation process as a cascade of several steps that start with the basic research and end with the commercialisation and use.
Basic research, which represents the first step of the Linear Model of innovation, is essentially the task of universities, research institutes or research laboratories of very large firms in high-tech businesses. Industry plays a role in this model, in most of the cases, only in the second phase (applied research). After the development phase, which can be either product or process development, the results reach the market.

According to the Linear Model of innovation, research represents the starting point of innovation. This does not portray correctly reality, since research could and should be present in all stages of innovation. According to the linear model, the commercialisation and use of the outputs represent the outcome of a one-way process composed of several steps, where research and development represent the most important phases.

The Linear Model of innovation represents a very simple abstraction of the innovation process, that presents several constraints and which does not reflect the way in which innovation is linked to the market. It is also considered a science-based innovation model because it sees R&D as the key factor to innovation.

It also explains the one-way link between knowledge and economic performance. Knowledge is generated in universities and research institutes, passed on to companies through publications, patents or other forms. These develop and produce the products that are further commercialised in order to reach the final users. All steps are sequential in time.

According to Mahjoubi (Mahdjoubi, 1997), the Linear Model is a theory of epistemology that characterizes the transfer of knowledge as involving refinement and adaptation from universal principles to particular instances, from comprehensive theory to specific application.

Many innovation development policies were and some still are consistent with the Linear Model. Science and technology policies have in fact been focusing primarily on government-funded R&D and government’s grants policy still remain in many countries a popular tool for sustaining the level of output and employment and for preventing economic depressions, keeping in line with the Keynesian economic policies.

Several studies argued that the Linear Model does not fit any more (if it ever did), because it does not take into account existing elements, such as feedbacks, crossed flows, reverse engineering, etc.

The Linear Model of innovation is very important in creating a way of thinking, in building a comprehensive way of understanding innovation: from knowledge creation to commercial exploitation. The “pipe-line metaphor” was, in fact, the starting point for the later – more complex – innovation models.

Both the OECD Frascati Manual (OECD, 2002) and the OECD Oslo Manual (OECD, 1996) definitions on innovation are based on the Linear Model of innovation.
The OECD Oslo Manual nevertheless recognizes, in opposition to the Linear Model on innovation, that “despite the considerable efforts of researchers, however, we are still a long way from understanding all of the factors which shape the rate, directions and effects of technological change, at enterprise, industry, regional or country level. There are many reasons for this. Some of these reasons are the lack of appropriate theory and this relates to the difficulties of embedding technological change into economic theory and analysis”.

In line with the Linear Model of innovation, technological development is classified in product and/or process development. But this distinction is not very clear since a technological advance may be considered a product development by its producers and a process development by those using it.

One of the limitations of the OECD Oslo Manual is that it focuses on enterprises. Enterprises play a unique role in innovation, but attention should be given to other innovation players too, such as research institutes, universities or technological centres, which complement and support enterprise effort to achieve more effective processes and novel marketed products. This work will demonstrate that these entities play a considerable role in a successful PDIP.

An important step forward from the Linear Model is represented by the fact that OECD Oslo Manual recognizes design as an important part of the innovation process. Design “covers plans and drawings aimed at defining procedures, technical specifications and operational features necessary to the conception, development and manufacturing and marketing of new products and processes”.

Despite the awareness of the limitations of the Linear Model, the main statistical indicators associated with this model continue to form the basis of the innovation surveys undertaken nowadays. These indicators are primarily associated with R&D expenditure as a percentage of GDP by government, private sector or funding organizations as elaborated in the Frascati Manual. In addition to these input measures, more sophisticated indicators associated with this model also measure outputs of the innovation process in the form of patents (number of patents application per million of population).

2.3.2. Non-Linear Innovation Models

Later innovation models emphasize the interactions that take place between and within firms and they tend to adopt a more systemic view of the innovation process. Opposed to the R&D oriented Linear Model, interactive approaches introduce the idea of adaptation and combination of existing and novel forms of knowledge focusing on the importance of firm’s external environment. It is argued that in addition to internal knowledge creation activities (among which R&D may be one aspect, especially in larger companies) enterprises acquire knowledge by reaching out into their external environment to a range of sources. These sources include: other companies (clients, suppliers, competitors, technology vendors, etc.), conferences and other dissemination events, journals and trade magazines, universities and R&D institutes, funding institutions. This aspect is of great importance for the analysis of entities’ collaborative R&D actions - the subject of this Thesis.
Kline and Rosenberg (Kline et alii, 1986) proposed a non-linear model of innovation (Figure 2.3.), known as the Chain-Linked Model.

![Figure 2.3. Kline's and Rosenberg's Non-Linear Model of Innovation](image)

This model, referred to in many documents, such as the OECD Oslo Manual, is consistent with a detailed evaluation of the nature of technology. The Chain-Linked Model begins with a basically linear process moving from potential market to invention, design, adaptation and adoption, but it adds several feedbacks/loops from each stage to the previous one.

The Chain-Linked Model emphasizes the necessity to replace the linear model with a more complex model in order to better understand the nature of innovation. It underlines the socio-technical nature of industrial and technological processes and the need to look at innovation as a complex system. In this model, the first path of the innovation process, central chain-of-innovation, begins with design and continues through development and production to marketing and distribution. The second path is a series of feedbacks (Mahdjoubi, 1997).

This non-linear innovation model emphasizes various paths that generate innovation and many feedbacks. The stored knowledge is considered normally as the key element generating innovation rather than research, as the linear model imposes.

There are several differences between the Chain-Linked model and the linear model of innovation. First, the model proposed by Kline and Rosenberg has several paths and many feedbacks that accompany the innovation process. The innovation process is seen as very complex (both technically and socially) and it is determined by the market needs and not by the technical opportunities or by the results of the research effort. Knowledge has a crucial role in innovation and it is considered as the source of innovation. Research does not appear only in the initial phase, as in the linear model, but it occurs during all phases of the innovation process.

Rosenbloom and Spencer (Rosenbloom et alii, 1996 a; Rosenbloom et alii, 1996 b) proposed a “Total Process” view on innovation, which represents an extension of the Chain-Linked model developed by Kline and Rosenberg, recognizing the organizational capabilities and the special characteristics of innovation built on discontinuities in technologies or markets. The firm-specific knowledge resulting from accumulated learning in the organization, the communities of practices of skilled technical people with common and complementary expertise working across the organization in specific tasks and the technology platforms are considered as the foundations of competitive advantage through innovation.
Another extension of the Chain-Linked innovation model was proposed by Mayers and Rosenbloom (Mayers et alii, 1998) and it is illustrated in Figure 2.4. Innovation is regarded as a system of interactions among different functions (marketing, research and development, design and engineering, production and distribution) and among different agents (clients, competitors, suppliers, technology centres and universities) in a way in which experience and knowledge are mutually strengthened.

Figure 2.4. Mayers’ and Rosenbloom’s Non-Linear Model of Innovation

Ralph Gomory’s Circle Model (Mahdjoubi, 1997) of innovation was developed as another alternative to the linear model of innovation. Ralph Gomory emphasizes that in the linear paradigm new things descend from the field of science into practice and become the genesis of an industry, eventually leading to product dominance. The basic research and the new technology make things get started.

The cyclic development process is a process of repeated, continuous, incremental improvement. It is well suited to represent manufacturing when a product is designed, built and prototyped, tested, re-designed for manufacturing, put into production, etc., paves the way to the next generation of products. The car industry, as well as many others from electronics to fashion industries, is an example of adoption of a cyclic development process.

There are several differences between the linear model of innovation and the circle model. The linear model is science-based, while the circle model of innovation is based on existing elements (existing knowledge, existing products, etc.) and the new output is developed and obtained by using the limited resources available with the restrictions imposed. The linear model of innovation is better suited to the early stages of an industry while the circle model applied well to the later stages.

An important emphasis of the circle innovation model is that the industrial success is, in fact, generating R&D expenditure, and not the other way around. The linear model is consistent with the idea that the simple existence of R&D generates innovation, which is not compatible with the Circle model of innovation.
By following the circle development model, the results obtained do not represent, in most of the cases, something completely new, and this could be regarded as a limitation of the model. In most of the cases, they are not revolutionary inventions, but they head to progress.

John Alic (Alic, 1992) argues that the Circle approach, compared to the linear model, gives equal weight to technical virtuosity in all of the functions: research, design, production and marketing and produces a model that stresses the importance of a close coupling among them.

Alic and Branscomb proposed a new perspective on innovation, but it is considered that their studies do not go far enough to articulate a new innovation model (Mahdjoubi, 1997). Innovation is considered a social process involving the application of knowledge, together with other inputs, like design, development and creation, thereby resulting some outputs of innovation that could be both tangible and intangible.

The artefact product should be viewed as the derivative, the consequence of research, design, development, production and marketing activities – the consequence of what people and organizations know (declarative knowledge) and can do (procedural knowledge). Technological innovation, especially in the later stage often called commercialisation is an activity pursued by business firms. (Mahdjoubi, 1997)

This view on innovation puts a special emphasis on engineering design and development (D&D) which are considered the core activities of commercialisation and the culminating point of innovation. When emphasizing research, as in R&D, development puts the knowledge into practice. When emphasizing design, as in D&D, the development implies an interactive process of conceptualisation, preliminary design, analysis, testing and redesign of the outputs (Mahdjoubi, 1997).

It is suggested that R&D should be used when one refers to activities that generate knowledge and D&D when referring to activities where knowledge is applied. Innovation is therefore seen as the result of the combination of new knowledge with existing knowledge.

Figure 2.5 illustrates an Open System Model of Innovation used in Canada (Government of Quebec, 1999). As in the case of the Chain-Linked model, multiple paths from which innovation may arise are underlined. New knowledge and the available knowledge, as well as market research studies, are used in the processes of product development and technology acquisition.

![Figure 2.5. An Open System Model of Innovation](image_url)

(Source: Government of Quebec, Conseil de la science et de la technologie, 1999)
Design is recognized as a step in acquiring innovation. After the production and marketing phases the outputs are introduced in the market and the process of generating innovation is a cyclic process. It differs from the Chain-Linked Model by the fact that there are no interactions during the production phase. Product development and technology acquisition are considered as key innovation phases.

Table 2.1 attempts to synthesize and analyse some of the most important elements of the main innovation models presented. Being an extension of Kline’s and Rosenberg’s model, the “Total Process” view proposed by Rosenbloom and Spencer was not included.

<table>
<thead>
<tr>
<th>Model Item analysed</th>
<th>Linear Innovation Model</th>
<th>Non-Linear Innovation Models</th>
<th>Rosenbloom and Spencer</th>
<th>Circle Model</th>
</tr>
</thead>
<tbody>
<tr>
<td>Key innovation factor</td>
<td>Research</td>
<td>Stored knowledge</td>
<td>Existing knowledge</td>
<td>Existing products</td>
</tr>
<tr>
<td>Main phase(s)</td>
<td>Research</td>
<td>Development</td>
<td>I. Design</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Development</td>
<td>Production</td>
<td>Development</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Marketing</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>II. Feedbacks</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Innovation is the result of</td>
<td>One-way development of several steps</td>
<td>Feedbacks</td>
<td>Different combination of the existing knowledge and existing products</td>
<td></td>
</tr>
<tr>
<td>Innovation is determined by</td>
<td>Technical opportunities or research effort</td>
<td>Market needs</td>
<td>Existing knowledge</td>
<td>Existing products</td>
</tr>
<tr>
<td>Portraying Reality</td>
<td>Simplified abstraction of reality; naïve representation of how actors and roles are linked in consortia Early stages of industry</td>
<td>Insight to the complexity of reality. Later stage of the industry Emphasizes the socio-technical nature of industry and technology</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Limitations</td>
<td>Simplified representation of reality Research is the starting point of innovation and creates innovation</td>
<td>The results is not always something new</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Other Aspects /Remarks</td>
<td>Industry is involved in the second phase (Applied Research)</td>
<td>Research appears in all phases</td>
<td>Industrial success generates R&amp;D expenditure</td>
<td></td>
</tr>
</tbody>
</table>

Both Linear and Non-Linear Innovation Models are useful to provide background to this thesis: the linear models express a simple, perhaps “naïve”, representation of how the different actors and roles are linked in consortia projects while non-linear models give an insight to the actual complexity of reality.

Our study is mostly based on the simple concepts of the Linear Model of innovation. We are aware that the linear model of innovation does not represent the correct abstraction of the innovation process, but due to the lack of freedom in some aspects of the analysis, and due to
time and manpower limitations, it seemed to be the most appropriate approach for the study conducted. In Portugal, government programmes that are aimed to foster innovation through the provision of financial and fiscal benefits for companies have been in place for almost 20 years. Therefore, product development innovation projects are strongly government-funded which is consistent with the more R&D based Linear Model of innovation.

Unlike the studies based on OECD Oslo Manual, which are made at enterprise level, our research is focusing on different types of economic entities participating in a product development innovation project: enterprises, universities, research institutes, association of enterprises and technological centres that build a consortium with the aim of developing an innovative product.

2.3.3. National and Regional Innovation Systems

Lundvall (Lundvall, 1992) and Edquist (Edquist, 2001) associate the approach to innovation based on the interactions among different companies with the “system of innovation”. This concept has been developed to explain innovation success at a national level and more recently has been applied to regions (Braczyk et alii, 1998). However, regional innovation systems share some characteristics from the national level, since they, naturally, inherit some of the characteristics from the national level.

Several definitions have been put forward to describe national and regional innovation systems. Chris Freeman – one of the pioneers of this approach - defines the innovation system as “the network of institutions in the public- and private-sectors whose activities and interactions initiate, import, modify and diffuse new technologies” (Freeman, 1987). Within this broad semantic framework, different approaches have emerged, mainly regarding the way to consider the institutions for innovation. Some research studies adopt an organisational approach, describing a national innovation system in terms of formal organizations and public institutions, such as public and semi-public technology service institutions, R&D laboratories, funding institutions and other public bodies such as institutions for patent regulation. Others adopt an institutional approach, where the concept of innovation system emphasizes the role of “soft” institutional forms, such as habits, norms and rules (such as trust) in facilitating the interactions that underpin innovative activity.

Aligned with the new innovation models, more sophisticated measurements of the interactive aspects and a broader interpretation of what actually constitutes innovation (not just technical) have emerged. An example is portrayed by the development of different studies conducted in order to measure and characterize innovation, such as Oslo Manual (OECD, 1996), which sets out the framework for innovation indicators used in the Community Innovation Survey.

In line with these new approaches, the present thesis characterizes innovation in collaborative R&D activities in Portugal, emphasizing the interactions between enterprises, R&D centres and other public or private institutions.
2.4. Innovation Analysis - Background Issues

The nature of the tasks that needed to be performed in order to reach the objectives set for this thesis, called for further background work in three different aspects:

- Data collection methods suitable for field studies on innovation;
- Identification and analysis of studies on innovation of relevance to the work;
- Brief characterization of innovation in Portugal.

This work allowed us to acquire a deeper insight into these important areas, this being of great relevance for the design of the survey, its field implementation and the analysis of results.

2.4.1. Data Collection Methods

The extensive literature abounds of data collection methods. Questionnaires, interviews, observations, testimonials, mass media /public hearings are just some of the data collection methods and procedures used in many different areas.

Data collection methods vary from methods generally associated with quantitative research, such as methods relaying on random sampling, structured data collection instruments that fit diverse experiences into predetermined response categories and statistical analysis to other type of methods typically associated with qualitative research. In between, there is a number of possible evaluation methodologies or methods combining different aspects of both approaches.

The selection of the appropriate data collection method is influenced by and influences several factors, such as the survey design (the selection of sample elements, probable response and non-response rates and the cost of data collection) and the quality of the final results. According to Statistics Finland (Statistics Finland, 2004), different data collection methods allow for very different sample sizes, and the number of respondents determines the degree of reliability with which the results may be generalized to various population segments. Because it influences the whole statistical survey process, the choice of the data collection method is not an isolated decision in survey design. In fact, the data collection method has relevant impact on the design and preparation of the questionnaire, on the quantity and quality of the data that is to be collected and on the cost and timetable of the survey.

The use of surveys in the fields of innovation has exploded in the past 10-15 years. Innovation surveys proved to be successful tools for gathering a huge amount of information on innovation with great value for analysing the innovation process, in general, with a focus on different aspects of the innovation: innovation inputs and outputs, the role of public and private institutions in innovation, corporate strategies, etc.

Innovation surveys, however, do have serious handicaps (Brusoni et alii, 1998), due to different reasons: they are often long, cumbersome and poorly written; they are often written to fit all sectors and therefore use general language; they usually have poor response rates; the structure of language of surveys can lead to misunderstandings; they are expensive to administrate.
Surveys usually contain sets of questions that can be classified in four different types:  
- closed or fixed alternative questions which lead to a forced choice among two or more answers;  
- open questions which do not have restrictions on the reply;  
- scale questions which are a type of fixed-alternative (i.e. strongly agree, agree, strongly disagree)  
- loaded questions\(^1\) (frequently used by Statistics Canada).

Surveys are conventionally divided according to the topics analysed. Many classifications of survey types have been made considering different factors: the general survey design, the data collection method or the technology for acquisition (Statistics Finland, 2004).

According to Statistics Finland (Statistics Finland, 2004), the term statistical survey covers, by definition, the following types of data:
- Total data (census survey), where data collection covers all elements of the target population  
- Sample data (sample survey), where the data collected refers to a selected sample from the target population (usually at random)  
- Data obtained from administrative registers (administrative records)  
- Derived statistical data (derived statistical activity), where data has been estimated, modelled or otherwise derived from existing data pools (Statistics Canada, 2004)

According to OECD OSLO Manual (OECD, 1996), innovation surveys can be classified into categories:
- Census or sample surveys  
- Mandatory or voluntary surveys

Table 2.2 summarizes the main survey types by mode of administration and data capture instruments. Table 2.3 illustrates the taxonomy of computer assisted interviewing methods, whose growing importance is undisputed. In the administration mode, one distinguishes whether interviews are used or respondents are expected to answer by themselves.

### Table 2.2. Survey types by mode of administration and data capture instrument

(source: Statistics Finland, 2002)

<table>
<thead>
<tr>
<th>Mode of administration</th>
<th>Paper questionnaire</th>
<th>Electronic questionnaire</th>
</tr>
</thead>
<tbody>
<tr>
<td>Self-completion</td>
<td>Self-administered questionnaire, diaries</td>
<td>Internet questionnaire, Computer Assisted Self Interview (CASI)</td>
</tr>
<tr>
<td>Interview</td>
<td>Interviewer-administered questionnaire</td>
<td>Computer Assisted Personal Interview (CAPI), Computer Assisted Telephone Interview (CATI)</td>
</tr>
</tbody>
</table>

\(^1\) A loaded question is a question with a false or questionable assumption and it is "loaded" with that presumption. The question "Can I speak with the person who manages your e-mail account?" is an example of a loaded question. The question assumes that there is another person managing your e-mail account prior to its asking. If you do not have any e-mail account, then the question is loaded.
Table 2.3. Taxonomy of Computer Assisted Interviewing Methods
(source: Statistics Finland, 2002)

<table>
<thead>
<tr>
<th>Specific method</th>
<th>Computer assisted form</th>
</tr>
</thead>
<tbody>
<tr>
<td>Face-to-face interview</td>
<td>Computer Assisted Personal Interviewing (CAPI)</td>
</tr>
<tr>
<td>Telephone interview</td>
<td>Computer Assisted Telephone Interviewing (CATI)</td>
</tr>
<tr>
<td>Self-administered form</td>
<td>Computer Assisted Self Interviewing (CASI), Computerized Self-administered Questionnaire (CSAQ)</td>
</tr>
<tr>
<td>Postal survey</td>
<td>Disk by Mail (DBM)</td>
</tr>
<tr>
<td></td>
<td>Electronic Mail Survey (EMS)</td>
</tr>
<tr>
<td>Panel survey</td>
<td>Computer Assisted Panel Research (CAPAR)</td>
</tr>
<tr>
<td></td>
<td>Tele-interview</td>
</tr>
<tr>
<td>Interviewer present</td>
<td>Computer Assisted Self Interviewing with Interviewer Present (CASI of CASIIP) Question Text on Screen: Visual (CASI-V) Text on Screen and on Audio (CASI-A)</td>
</tr>
</tbody>
</table>

Each survey type has advantages and disadvantages. Face-to-face interview surveys, due to the necessary fieldwork and inherent organization, require more resources, generating a considerably higher cost than postal or telephone surveys. The strong point is that the presence of the interviewer makes the situation controllable and any questions or doubts arising can be easily clarified. The risk is to have a higher influence on the respondent than in other interviewing methods.

Postal surveys have as main advantage the low costs associated. Besides, they provide an easier way to answer to sensitive questions than in an alternative telephone or face-to-face interview.

Computer assisted data collection methods offer many possibilities compared to paper questionnaires: they facilitate the use of diverse questions and response combinations; it is possible to attach background information; checks for correctness or logical consistency can be programmed; and so on.

A self-administered electronic questionnaire can be based on the Internet and an electronic questionnaire can be sent as an e-mail attachment. The main problems associated are related to the coverage as well as to the lack of an adequate sampling frame. Moreover, not everybody has access to Internet and there is no such a thing than a complete list of e-mail addresses. With regard to sensitive or intimate questions, however, they may produce more reliable responses than an interview and may also reduce non-responses (Statistics Finland, 2002).

Statistics Canada (Statistics Canada, 2004) divides data collection methods into: personal interviews (face-to-face, CAPI, telephone and CATI), self-composed (mail survey and hand-delivered questionnaire) and other methods, such as Electronic Data Reporting (EDR), the Internet-based methods and combination of methods.

Considering the aim of the present research project and the relatively small sample, the CAPI method was considered the most appropriate for data collection. Even if the costs are higher, face-to-face interviews were important at this stage to clarify possible doubts, to help us calibrate and improve the questionnaire and to prevent errors caused by wrong interpretations from both the interviewer and the respondent sides.
2.4.2. Selected Studies on Innovation Characterization

Increasing interest in understanding the dynamics of innovation, the innovation flow or the mechanics of the innovation process motivated research in the area. However, most of the existing studies undertaken at international, European, national, regional or project level focus mainly on analysing the impact of the innovation activities.

There are hundreds of government policy measures and support schemes targeted at innovation, some of which have already being implemented and others being in place or still in preparation. The diversity of these measures and schemes reflects the diversity of the framework’s conditions, cultural preferences and political priorities regarding innovation.

Some studies on innovation characterizing which offer background to are briefly introduced below.

The Community Innovation Survey (CIS) (an initiative which stays within the CORDIS EC information system) emerged as an application of the work developed within the Organization for Economic Co-operation and Development (OECD) in the measurement of the innovation activity. The CIS builds on the application of a survey methodology focusing on the analysis of the innovation activity within the enterprise boundaries.

Launched in 1991, CIS I has been jointly initiated and implemented by Eurostat (Statistical Office of the European Commissions) (Eurostat, 2003) and DG Enterprise (Enterprise Directorate-General, 2003), under the aegis of the European Innovation Monitoring System (EIMS), part of the Innovation Programme. Statistical Offices in the Member states, independent experts and OECD jointly collaborated to develop this methodology. The objective was to collect comparable enterprise-level data on inputs and outputs of the innovation process across a wide range of industries and across Member States and regions. It provided a major new source of information on innovation at enterprise level (see Cordis 11-19).

The CIS was adopted as a framework for innovation analysis by most of the European countries and even by other countries outside Europe.

The CIS is focusing on the following areas:
- expenditure on activities related to the innovation of new products (R&D, training, design, market exploitation, equipment acquisition, etc.);
- outputs of incrementally and radically changed products, and sales flowing from these products;
- sources of information relevant to innovation;
- R&D performance and technological collaboration;
- perception of obstacles to innovation and factors promoting innovation.

The concerns and criticism around CIS arise mainly around its limitations. For example, it is argued that it does not deal with the institutional factors that corroborate successful business innovation, which makes one interpret its findings with care and, where possible, with the extra-support of additional studies.
CIS provides a close look to the innovation activity at company level, focusing mainly on the impact of the innovation activity, though not analysing in depth innovation itself. This has resulted in the acceptance of a loss of information on innovation traded for the establishment of shorter time lags for the analysis. According to Bóia, Conceição and Santos (Bóia et alii, 2003), data should be assembled in order to characterize the organization of the company activities oriented towards innovation, the motivations underlying the introduction of innovations, the difficulties hampering the innovation process and the network of liaisons and cooperation’s with other entities as other enterprises (parent company, suppliers, clients, competitors), Universities and R&D Laboratories. This last aspect is strongly linked the present work.

The Trend Chart on Innovation in Europe (see Cordis 11-19) was build upon the “First Action Plan for Innovation in Europe”, launched by the European Commission in 1996, providing for the first time a common analytical and political framework for innovation policy in Europe. Run by the Innovation Unit of DG Enterprise, it pursues the collection, regular updating and analysis of information on innovation policies at national and Community level, with a focus on: innovation finance; the setting up and development of innovative businesses; the protection of intellectual property rights; and the transfer of technology between research and industry.

This Trend Chart supports policy makers in Europe with aggregate comparative information and statistics on innovation policies, performance measurements and trends in the European Union. It is also an European forum for benchmarking (that is, comparative evaluation using pre-defined performance indicators or measurement indexes) and the exchange of “good practices” in the area of innovation policies.

The European Innovation Scoreboard (EIS) (see Cordis 11-19) is the main statistical tool of the European Trend Chart on Innovation. It provides key indicators to track the EU countries progress towards the Lisbon European Council target of “becoming the most competitive knowledge-based economy in the world by 2010”.

The EIS builds on a set of pre-defined commented indicators which are organized under four distinct categories: human resources; creation of new knowledge; transmission and application of knowledge; innovation finance, outputs and markets. It allows relative strengths and weaknesses of the innovation activities of the EU member States to be assessed and, for a limited number of indicators for which comparable statistical data is available, it allows the EU performance to be compared against with that of the United States and Japan.

The EIS (see Cordis 11-19) is itself one component of a much broader benchmarking exercise run by DG Enterprise covering European enterprise policy and competitiveness as a whole (see Cordis 11-19). The indicators of such exercise regard human resources (i.e., population with tertiary education; participation in life-long learning; employment in medium-high and high-tech manufacturing; etc.); knowledge creation (i.e., public R&D expenditure; EPO high-tech patent application per million population, etc); transmission and diffusion of knowledge; innovation finance, output and markets.

The European Commission-promoted surveys/scoreboards (CIS and EIS) provide the only comparable innovation data across European countries and regions (where available). But one should recognize that there are many other smaller scale surveys (qualitative research) that have developed further indicators of innovation.
One of such initiatives is the STRINOP - Thematic Network project (Strengthening Regional Innovation Profile) (www.strinnop.net), which is a part of the Innovating Regions in Europe (IRE) Network, with members from 12 European regions (from Portugal, it includes the North region) aiming to “obtain a clearer innovation profile and to create a step-by-step method for strengthening the innovation profile in all interested regions”.

A key process in the STRINNOP project was the review of regional quantitative and qualitative innovation indicators intended to measure not only the innovative performance of the regional economy, but also the regional innovation policy. The draft indicators refer to the identification of regional competences; creation of regional knowledge; stimulation of innovation activities; implementation of firms’ innovation activities; focus on regional strength: clustering and networking; internationalisation; marketing of the regional innovation profile. Three accompanying steps were devised: coordination of the regional innovation supporting infrastructure; accompanying step: monitoring and evaluation of the regional innovation activities; accompanying step: financing of the regional innovation activities and supporting infrastructure.

The STRINNOP approach is addressing some limitations of current innovation indicators by giving greater attention to the issue of the external environment for innovation, commonly recognized as a central element in a regional innovation system.

The Centre for Policy Research on Science and Technology (CPROST – www.sfu.ca/cprost) at Simon Fraser University in British Columbia (Canada) is undertaking research in the same area. Research is being pursued to develop and apply performance indicators, particularly output measurements, to quantify and assess the long-term growth associated with technological product and process innovation. Using British Columbia as a basis for this research, the same program also seeks to explain regional aspects of innovation. The projects undertaken deal with advanced international studies in innovation management, innovation and competitiveness, innovation system research network and measurements of the technological innovation in the public sector.

A project focusing on innovation at firm’s level worthwhile to mention was undertaken in the Netherlands. Cozijnsen, Vrakking and Ilzerloo (Cozijnsen et alii, 2000) undertook a survey of a completely different nature but of great interest and relevance as well, given the scope of the present work. They made an overview of successful innovation projects which were classified according to five different perspectives: adoption and diffusion, planned change, organizational structure, implementation and strategy. The work consisted in the analysis of the success and failure of 50 innovation projects in Dutch companies, emphasizing mainly the implementation phase and the implementation factors of innovation in organizations. However, no clear conclusions are presented justifying the success or failure of the projects analysed.

Despite the several attempts, the relevant literature lacks in providing clear conclusions supported in quantitative analysis on the critical factors having a positive effect on successful innovation. This is mainly due to the following reasons (Wolfe, 1994):

- Most of the studies concentrate only on a part of the innovation process and it is often not very clear to which part of the process the study is limited.
• The theoretical basis of these studies depends partly on the particular aspect of the innovation process each study focuses on. Many studies do not describe their theoretical context.
• The way in which studies evaluate and undertake successful innovation varies widely or is hardly touched upon. Moreover, the different measures used to rate successful innovation do not make it any easier to generalize the findings of the different studies.
• The studies often lack clear indication of the types of innovations investigated. In all likelihood a simple focused technical innovation is based on different success factors rather than a complex organizational innovation.

The aim of the research work leading to the present M.Sc. thesis is to analyse and characterize the innovation process by focusing on individual product development innovation projects (PDIPs) undertaken by enterprise-university consortia in Portugal. Differently from other studies on innovation conducted in Portugal at a macro scale, this research study is focusing on the actors performing innovation and on the innovation they undertake through collaborative projects, with the aim of identifying factors determining the success or failure of the projects undertaken by such actors gathered in consortia.

2.5. Innovation in Portugal

2.5.1. Background Elements

2.5.1.1. Science, Technology and Innovation Policies in Portugal: Brief Overview

Historical background of S&T in Portugal
According to Caraca (Caraca, 1998), the birth of science and technology (S&T) policy in Portugal can be tracked back to 1967 when the National Board for Science and Technological Research (JNICT – Junta Nacional de Investigação Científica e Tecnológica) was created. The appointed task to that government body was that of coordinating S&T efforts of different Ministries (Education, Agriculture, Public Construction and Economy) in order to promote and stimulate the technological basis of national economic growth. In the early 80s, JNICT launched the first integrated S&T development plan which had clear science policy measures (directed to university research) and technology policy implications (promoting industry-university projects, proposing an innovation agency and encouraging national laboratories in undertaking joint collaboration projects with enterprises).

In 1976 the National Institute of Scientific Research (INIC -Instituto Nacional de Investigação Científica) was created under the Ministry of Education to finance research conducted in universities. The overlapping of JNICT and INIC roles and activities become clear when JNICT obtained the means to finance university research within the scope of Community Support Framework I (CSF I). In 1991, INIC was dissolved and JNICT took over its work (Oliveira, 2002).
Science and Innovation Policies in Portugal: A Brief Overview

Innovation activities benefit from both the S&T and the industrial policies in Portugal. Since 1986 Portugal has received regular financial support from the European Community with the aim of reducing the disparities with other European Union countries. This support was given within the scope of different framework programmes in different periods: the first from 1986 to 1988 was called the Prior Regulation; the second was the Community Framework Support (CSF) I, from 1989-1993; the third CSF II from 1994-1999 and the fourth covers the 2000-2006 period (CSF III).

During the period covered by CSF I (1989-1993), a considerable amount of funds was invested in the development and support of the Portuguese industry.

The most significant programmes supported by CSF I for the Portuguese S&T development were PEDIP (1988-1992) focusing on the industry and CIÊNCIA (1990-1993) towards pre-competitive research. The CIÊNCIA programme aimed to improve the existing laboratories and research centres and to create new research centres and institutes in a number of defined priority domains: information technology and telecommunications; production technology and energy; new materials S&T; biomedical sciences; agricultural sciences; biotechnology and fine chemistry; marine S&T. Twelve new R&D institutes were thereby created involving 38 sites across Portugal, and the foundations of two S&T parks were laid. With the funding from STRIDE (EU Programme/ S&T for Regional Innovation and Development in Europe) an innovation agency was created. PEDIP (EU support programme for the industry aimed at strengthening the technological infrastructures supporting industrial activities. It enabled the creation of a national system consisting of 42 entities: metrological laboratories, technological centres, new technology institutes, technology transfer centres, demonstration units (autonomous or not), technology poles and incubation centres (part of technology poles or other institutions) (Caraça, 1998), (Oliveira, 2002).

The STRIDE-Portugal Programme was designed to complement the CIÊNCIA programme. It supported not only the creation of an Innovation Agency, but also the installation of S&T Parks.

According to Oliveira (Oliveira, 2002), the linear conception of the scientific activity was intrinsic to the investments made during CSF I. This was focused on the strengthening or the creation of means and resources, but lacked articulation and optimisation within the still fragile national system of innovation. Although the Ministry of Science and Technology (S&T had a Ministry for the first time in 1995) as well as the Ministry of Economy and the Innovation Agency have made a strong attempt to bring enterprises and research institutions closer together, the articulation between the various national innovation system agents continues to be under-performing.

With the approval of the second CSF (1994-1999), the successors of CIÊNCIA and PEDIP programmes - PRAXIS XXI and PEDIP II - pursued the investment in the reinforcement of the Portuguese industry and of the technology infrastructure system. PRAXIS XXI (1994-1999) was launched to pursue and complement CIÊNCIA in funding both S&T infrastructure and R&D projects. It was also set up to provide continuity to CIÊNCIA and STRIDE in the creation of R&D infrastructures of common use, in the creation or expansion of R&D laboratories and giving support to the set up of S&T Parks.
PEDIP II emerged as a natural follow-up of the first PEDIP programme, aimed to promote the sustained growth of the competitive position of Portuguese industrial companies, by increasing their capacity to respond to rapid technological and market changes while promoting the modernisation, diversification and internationalisation of the industrial fabric.

While CSF focused on the S&T policies in Portugal and the related R&D activities as major innovation factors, the CSF II started to make a clear distinction of innovation and innovation policies.

As reported in the European Trend Chart on Innovation (Country Report: Portugal) (Cordis, 2000), the year 2000 started a new period in the configuration of the support instruments for science, technology and innovation policies. PEDIP II and PRAXIS XXI ended and a new set of programmes covering the 2000-2006 period started: the Operational Programme for the Economy (POE) run by the Ministry of Economy, the Operational Programme Science Technology and Innovation (POCTI) and the Operational Programme for the Information Society (POSI), the two last directly managed by the Ministry for Science and Technology.

POE, replacing PEDIP II, is aimed at promoting the factors which were considered critical for strengthening companies competitiveness (quality and sustainability; human resources competencies and skills; internationalisation; innovation). The purpose is to further support firms in adopting strategies based on product differentiation and dynamic competitiveness factors instead of cost-based strategies. Its main axes are: acting over firms’ competitiveness factors, promoting strategic development areas and improving business environment. When comparing with PEDIP II, POE has a wider scope (it is no longer focusing only on manufacturing industry) and makes stronger use of information technologies to facilitate the interactions between firms and public administration (Cordis, 2000). POE also addresses the promotion of clustering and cooperation for innovation.

POCTI is an evolution of the former PRAXIS XXI. It is aimed to reinforce Portugal’s scientific background and to stimulate scientific and technological culture and the cooperation between firms and R&D organizations. It develops along three subprograms: training and qualifying human resources in S&T activities; developing S&T and innovation systems; and evaluating, observing, planning and following up the activities of the various elements of the S&T system (Cordis, 2000).

POSI follows former initiatives in the field that began with the creation of the so-called Mission for the Information Society. It is the first time that a stream of a supporting framework specifically addressing the preparation of the information society has been explicitly included in the CSF. Its main purpose is to promote the social awareness about, and use of, information technologies while making them widely accessible. The main axes defined are: developing human competencies; Portugal Digital, on disseminating the use of computers and Internet, while fighting exclusion; modernization of Public Administration; observation, follow-up and evaluation as to monitor policy measures (Cordis, 2000).

With CSI III and its supporting programmes, innovation is considered a relevant issue, and both POE and POCTI emphasize the need to promote innovation. POE is addressing the promotion of cooperation for innovation and clustering in four areas: mobilisation of new ideas and new entrepreneurs; promotion of new spaces for economic development; promotion of technological, quality and training systems; supporting of associative ness and enterprise information.
Productive Structure and Specialization

The Portuguese economy is small and open, increasingly integrated in the global world economy.

According to Oliveira (Oliveira, 2002), in the 80s more technology intensive enterprises emerged in Portugal in the Lisbon and Porto regions, taking advantage of a better skilled workforce, market opportunities and the relative proximity of the main and potential users. However, the modernisation of the Portuguese industry that occurred during the 80s and 90s focused essentially on the machinery and manufacturing equipment and little was done concerning the qualification of human resources. The Portuguese industrial fabric consists mainly of micro and small enterprises (with less than 50 workers). Portuguese industry has traditionally specialised in low-technology intensive sectors which are also labour-intensive. According to the same source, productive specialisation continues to strongly emphasize the textile/leather sector and metal products are emerging as a very significant sector. The competitive sectors of the Portuguese manufacturing industry include: food & drinks; textiles and clothing; shoes & leather; timber, cork and paper pulp; mould & dies; glass; other non-metallic mineral products; electrical machinery and transport equipment. The productive specialization is focused essentially on low-technology intensive sectors which need and involve little innovation (in equipment). Two medium/high technological intensive sectors have started to emerge: transport equipment and electrical machinery.

As the results of the European Trend Chart on Innovation (Cordis, 2003) illustrate, at the end of 2002 and during 2003, the Portuguese economy was characterized by a slowdown, mainly due to the contraction of the domestic demand. The Bank of Portugal projections for 2003 indicate a negative change in GDP, between 1% and 0%. Unemployment increased, especially in some more sensitive areas, leading the Government to launch a specific programme on economic recovery in depressed regions. Public finances continued to be the major Government concern, with a view to meet the Stability and Growth Pact budget deficit targets.

According to Conceição and Heitor (Conceição et alii, 2000), the level of the measures that indicate the extent to which Portugal is engaged in the knowledge economy is relatively low, but the growth rate in recent years has been very high. The growth rate is close to 7% a year, which is almost the double of the growth rate of knowledge-based industries for the OECD countries (3.5%) and for the EU (3.1%). This growth rate is however applied to a very small absolute level when compared with other European countries.

Portugal has also shown the largest percentage increase on R&D gross domestic expenditure of all OECD countries. Between 1995 and 1997, the R&D expenditure increased at an average of 9.4% per year in Portugal, while in the OECD as a whole it increased only 4.5%. This growth represented a recovery from the slowdown of the period 1991-1995, when the Portuguese R&D expenditure has increased only 3.8%, following to a 14% increase between 1985 and 1990. In the case of Portugal, most of the R&D expenditure is supported by public funding and undertaken in the university and R&D institutes (around 70% of the R&D is publicly funded), while in most of the advanced countries is the other way around (around 70% in industry, i.e. private funding, and 30% in the university supported by public funding).

Holding the EU Presidency during the first half of the year 2000 led to a significant assignment of resources for Presidency actions, somewhat delaying decisions and policy
making in the domestic field, thereby contributing to scarce legislative production in the innovation policy area. Very important however was considered to be the agenda defined by Portugal for the EU Presidency: preparing Europe for a knowledge-based society and stressing the relevance of innovation and enterprise policies (Cordis, 2000).

Several initiatives, programs and mechanisms helped Portugal’s economic growth, such as programs from the Ministry of Economy (PEDIP, PRODIBETA, IMIT), Ministry of Science (Praxis XXI) or European programs (BRITE-EURAM, ESPRIT).

Recognizing the necessity to adapt the Portuguese textile industry to international standards, mainly due to the increased competition following the GATT agreements, the EU Council adopted a specific program for the modernization of the Portuguese textile and clothing industry - IMIT (Textile Industry Modernization Initiative) (IMIT, 1995) for the period 1995-1999. IMIT was composed of three sub-programs: Sub-program A (Enterprise modernization) aimed to stimulate directly enterprises’ initiatives concerning the development of the projects for enterprise modernization and re-organization; Sub-program B (Access to capital) with the goal to create financial instruments, providing to the enterprises from the textile sector an improved access to banks financing and the diversification of the traditional financing instruments; Sub-program C (Involving enterprises) containing initiatives aimed at involving the enterprises from the textile sector by supporting their approach.

PRODIBETA (Environment Technologies and Equipments Industry Development Programme) had as objective the increase of the importance of the industry producing environment technologies and equipments in Portugal. This programme supported enterprises producing goods and equipment with projects to manufacture machines and equipments, tools and machine-tools, equipment for industrial control, equipments and integrated installations for environmental protection and energy saving. It also supported service enterprises with projects in the following areas: services supporting industry in the environment protection technologies and other services specially oriented for the equipment manufacturing industry.

European research activities are structured around consecutive four-year programmes, or so-called Framework Programmes

The Industrial and Materials Technologies (BRITE-EURAM III) (Cordis, 1994) programme (1994-1998) provided support to industry, academia and research organisations for pre-competitive collaborative and cooperative research in materials, design and manufacturing technologies. In addition, this programme included a special emphasis on transport sectors - aeronautics, automobiles, ships and trains. The main aims of the programme were: stimulation of technological innovation; encouragement of traditional sectors of industry to incorporate new technologies and processes; promotion of multi-sector and multi-disciplinary technologies; development of scientific and technological collaboration. The range of BRITE-EURAM activities covered shared-cost actions; technology stimulation measures for SMEs; thematic networks; accompanying measures; Marie Curie research training grants; ECSC steel research.

Information Society Technologies (IST) actions in the EU’s Fifth Framework Programme (FP5) cover the period 1998-2002, while the Sixth Framework Programme (FP6) sets out the priorities - including the Information Society Technologies (IST) priority - for the period 2002-2006.
In the 1980s and early 1990s the earlier Esprit programme followed a technology-push policy aimed at strengthening the growing of European IT industry. The new focus of IT RTD under the Fourth Framework programme has been the emerging information infrastructure, which will provide the basis of the global information society of the future. The programme was in consequence to a greater extent led by the needs of users and the market. The overall objective was to contribute to the healthy growth of the information infrastructure so as to improve the competitiveness of all industry in Europe, not just the IT industry, and to help enhance the quality of life.

The programme emphasised the ease of access to information, to services and technologies for companies, administrations and individual citizens. Encouraged activities stress the use and usability of technologies and best practice. The RTD areas covered are those most vital to the development of the infrastructure, taking into account the need for selectivity and concentration of effort.

**Recent Innovation Promotion Initiatives**

In spite of the grey picture described by the President of the Republic (Cordis, 2000) arguing that the Portuguese public administration is heavy, slow and bureaucratic, thereby constituting an “obstacle” for the most innovative sectors, it should be acknowledged that considerable improvement has taken place in recent years and a number of success cases in innovation can be identified.

Increasingly aware of the key role of innovation, during the last years the Government’s actions were mostly defined in the context of the Programme for Productivity and Economic Growth (PPCE). Seminars were organized with the participation of the President of the Republic and the “Innovation Week” was launched, which showed examples of excellence in science, technology and innovation. COTEC – an association aiming at the promotion of innovation in Portugal was launched, under the patronage of the President with the contribution of more than 100 of the largest Portuguese enterprises, which are responsible for over 17,5% of the GDP. COTEC contributed to put back “innovation” into the top of economic policy agenda, even though not reaching yet the status PROINOV was promising in 2001 (Cordis, 2000).

Another positive development was the co-operation between two main Ministries concerned with innovation: the Ministry of Economy (MEc) and the Ministry of Science and Higher Education (MCES). They joined forces to launch IDEIA – a programme on the promotion of research and development co-operation among companies and S&T organisations (Cordis, 2003) – pursuing previous collaborative research programmes such as Praxis 3.1 and FC-PME.

Several other actions were undertaken to support innovation and to promote an innovation culture in Portugal. In the field of education, a draft basic law on education was disclosed; one of its headlines is the increase in the minimum education time from 9 to 12 years. The General Directorate on Vocational Training was created, which is in charge of lifelong education. A pre-draft of a new law on Vocational Training was also made available for public discussion.

Public authorities seek also to improve their capabilities to support innovation policy makers in the diffusion of information and interaction with other actors relevant for the innovation policy. The diffusion of information on the Portuguese scientific and technological system is a
task of the Science and Technology Observatory (OCT, currently OCES – the Observatory of Science and Higher Education). This entity generates and publishes R&D statistics regarding the advance of the information society, government budget appropriations for R&D and the programmes for advanced training of human resources in S&T. OCES were made available the results of CIS (CIS II and CISIII) as well.

Regarding the current structure of the national system of governance of innovation policy (Annex B, Figure B.1), it should be noted that only the ministries which have responsibilities over organizations deemed to be relevant players in the innovation field are mentioned. Three other ministries, although without fulfilling this requirement, also have a bearing on innovation policy: the Ministry of Finance, for obvious reasons; the Ministry of Defense, due to the innovation-related implications of defense policy; and the Ministry of Towns, Territorial Planning and Environment, which is responsible for the environmental policy (as well as for the Regional Coordination Commissions, dealing with regional development matters). The two main players in the innovation field are however the Ministry of Economy (MEm) and the Ministry of Science and Higher Education (MCES). Within the context of innovation, MEm has responsibilities over several bodies: IAPMEI (the Institute for Support to Small and Medium Sized Firms and Investment - that provides supporting investment by SMEs and new entrepreneurs); API (Portuguese Investment Agency - a new agency mainly concerned with the attraction of foreign investment); ICEP (the Investment, Trade and Tourism of Portugal Institute, whose mission was changed with the creation of API; it will increasingly focus on foreign trade promotion, including the development of a new project on the international projection of Portuguese brands); IPQ (the Portuguese Institute for Quality that manages and promotes the development of the Portuguese Quality System, which includes the national standardization, accreditation and metrological bodies); INPI (the National Institute for Industrial Property is the body responsible for granting industrial property rights, as well as for the diffusing patent information as an instrument for innovation) and INETI (National Institute for Engineering, Technology and Innovation, the largest Portuguese state laboratory) (Cordis, 2000).

The MCES supervises several bodies that could be classified into six categories (Cordis, 2000): consultative bodies (including the Higher Council on Science, Technology and Innovation); management bodies of specific programs (like POCTI and PRODEP); service providers (which includes as main bodies OCES – the Observatory of Science and Higher Education and GRICES – the Bureau for International Relations on Science and Higher Education); public laboratories (such as LNEC, INETI, IPIMAR and INIA); public institutions (the main one being the Foundation for Science and Technology); agencies (the reference agency being the Innovation Agency).

The main public institute under MCES is FCT (the Foundation for Science and Technology) (www.fct.mces.pt) aimed at: promoting and financing programs and projects concerning scientific research and technological development; fostering the diffusion and dissemination of scientific and technological knowledge, as well as the scientific culture; financing postgraduate education and the qualification of researchers; promoting the creation of support infrastructures for scientific and technological activities.

The Innovation Agency (AdI – www.adi.pt) is aimed at promoting entrepreneurial innovation and technological development in Portugal and at fostering market-oriented R&D cooperation between Portuguese and foreign research centers and enterprises. AdI is a major entity in charge of managing the innovation support system, in the context of both POCTI and PRIME: integration of PhD’ and M. Sc.’ in companies and technology centers; the IDEIA initiative on
the launching of R&D projects carried out by consortia between companies and scientific firms, quite similar to earlier programmes that supported the projects targeted by the present work; the NITEC initiative on the creation of R&D nuclei in companies; and the DEMTEC action on pilot projects concerning innovative processes or products.

Concerning the information society, many actions were launched, which include: POSI (the Action Plan for the Information Society), the Action Plan on Electronic Government, the National Broad Band Initiative, the National Programme for the Inclusion of Citizens with Special Needs and the National Programme on Electronic Purchasing.

The launching of the QUADROS Programme may also have an important contribution towards fostering innovative organizational and management practices in enterprises, especially in SMEs. The transformation of POE into PRIME and the new mood of cooperation between the MEc and MCES were relevant developments for innovation policy making (Cordis, 2003).

The background guiding long-term strategy lies on the PPCE, comprising a wide set of measures aimed at improving Portugal’s competitiveness and attractiveness as an investment location. It also encompasses some actions specifically dealing with the establishment of an innovation friendly framework. A new Competition Law was passed, and the Competition Authority was created as an independent body to supervise competition practices. With regard to the protection of intellectual and industrial property, a new Industrial Property Law, intended to strengthen the industrial property as to encourage innovation, was published and came into force. The PPCE puts also a strong emphasis on venture capital as an instrument for promoting innovation. The revision of the legal and tax framework for venture capital activities were pursued and a new venture capital syndication fund was created (Cordis, 2003).

Five recent new measures on innovation financing, from which three had already been announced in the context of the PPCE were launched building the current framework (Cordis, 2000):

- **IDEIA** (Applied Research and Development in Companies), supporting the launching of consortia between universities and/or public research organizations and companies aimed at developing new products, processes and services;
- **NEST** (New Technology Based Companies), providing support to the creation of new technology-oriented companies with the aim of capitalizing over the country’s investment in scientist and engineer’s education;
- **NITEC** (Incentive System for Creating R&D Nuclei in the Company Sector) is aimed at creating in-house R&D competencies in firms, as well as to enhance their capabilities in the areas of design and implementing projects for developing new products and/or processes and assimilating external technologies and knowledge;
- **DEMTEC** (Incentive System for Undertaking Pilot Projects Concerning Technologically Innovative Products and Processes) is focusing on the industrial validation of knowledge relating to the application of new technologies, as well as on the demonstration and diffusion of such applications;
- **QUADROS** programme is aimed to improve the level of technical skills in SMEs through a mechanism of financial support to the salaries of young graduates (in engineering, economics, management and scientific fields) recruited in SMEs.
As already stated above, the first of these mechanisms is of a similar type of the ones that have previously financed the consortia projects that were analysed in the course of the present work, in this case with a particular emphasis on product development.

2.5.2. Studies on Innovation

There are several studies on innovation conducted in Portugal. Two of the most important ones, given the scope of this Thesis, are briefly discussed below: the Community Innovation Survey and The European Innovation Scoreboard for Portugal.

2.5.2.1. The Portuguese Community Innovation Survey

After an experimental survey in the area of innovation in 1990, Portugal participated in the second and third Community Innovation Survey (CIS).

The Portuguese CIS III (2001) followed closely the common methodological guidelines provided by Eurostat for all countries. The Portuguese questionnaire is essentially a translation of the given questionnaire by Eurostat, but includes some specific national questions (Bóia et alii, 2003).

The main outcomes of CIS surveys refer to:
- Innovation extension
- Innovation firm by size
- Distribution of expenditure in innovation for industrial firms
- Distribution of expenditure in innovation for service firms
- Innovation intensity for industry and services
- Effects of innovation reported as being of high impact
- Sources of information reported as highly important for industry and services
- Highly relevant cooperation partners in industry and services
- Innovation sources of highly importance for industry
- Innovation barriers of higher importance for the industry sector

Summarising the results, Boiá, Conceição and Santos (Bóia et alii, 2003) concluded that the results show a significant increase in the global indicators of innovation: proportion of innovating enterprises, product and process innovation, innovating activities and innovation intensity. Figure 2.6 portrays the current Portuguese positioning in the EU, concerning service and industrial innovating firms, as well as the evolution that was observed between CIS II and CIS III.
Figure 2.6. Current Portuguese Positioning in the EU against the results of CIS II

(1) For comparison with data in 1995-1998 some Sub-sectors are not considered (NACE 63, 73, 74.3 and 64 except 64.2) and the industrial firms in between 10 and 20 employees that were surveyed in 1998-2000
(2) Includes the results not considered in (1)

Figure 2.6 illustrates the fact that Portugal's increase in innovating companies was more or less equivalent in Manufacturing and in Services, maintaining the balance already observed in the CIS II.

The results of CIS III show that Portugal's performance in the Manufacturing sector increased significantly. But it is important to mention that for the same level of share of expenditure different outcomes were obtained, thereby suggesting different levels of efficiency (Bóia et alii, 2003).

The main results obtained from the CIS III that may be regarded as benchmarks of the Portuguese innovation system, were emphasized by Bóia, Conceição and Santos (Bóia et alii, 2003) and are briefly presented below:

- At the national level, a proportion of 44.3 % innovating enterprises was obtained in the reporting period (1997/1998). Manufacturing and Services reached similar growths in the period, respectively 42.4% and 48.7% and 71.3% of the service enterprises declared to have introduced novel innovative products, whereas in manufacturing sector the proportion was 70.1%.
• The results obtained for the share of turnover of innovative enterprises due to Product Innovation are lower in CIS III than those obtained in CIS II: a share of turnover of about 38% has decreased to 31% for all enterprises introducing innovation in the Manufacturing sector; and has decreased from approximately 40% in CIS II to 29,5% in CIS III for all enterprises introducing innovation in the Manufacturing sector; and approximately 40% in CIS II and 29,5% in CIS III for those that introduced Novel Innovations. In Services, although more innovative and 52% higher in terms of Total Turnover of innovative firms, the financial outcome obtained from innovation in terms of share of Turnover is lower than in Manufacturing.

• Patent application distribution in CIS II is consistent with the distribution of valid patents in CIS III, probably due to a change in the status of the applications that were accepted as valid patents during the CIS time frame. There is also a higher number of patenting activities for the innovating enterprises as opposed to the non-innovators taken as a group. However, the only clear message is that the Portuguese companies usually ignore or do not choose to use patenting as an IPR protection tool.

• Innovation was undertaken mainly in house: roughly 50% higher than that developed in cooperation with and/or by other enterprises or institutions. Process innovators were relying significantly more on cooperation than on just outsourcing. The great majority of companies prefer to innovate internally within the firm or group and smaller companies search more often for external help than larger ones, probably due to the lack of critical mass and to the scarcer resources.

• In the manufacturing sector, the smaller companies are able to capture a higher share of the turnover due to product innovation from novel products than the larger ones. In the Services Sector, this preponderance occurs in the medium-sized companies. There is also a similar level of innovation in most of the sectors considered according to their technological intensity within manufacturing. This is an evident pervasiveness in the increase of the share of innovating companies in the Portuguese economy. The results in the services sector show also a significant increase in the proportion of innovative enterprises for all sectors.

• The proportion between innovators that are part of a group and those that are not is higher in the Manufacturing sector than in the Service sector, a characteristic also verified in CIS II. According to CIS III, new firms provide more innovative companies in the Services sector than older firms and exactly the opposite can be observed in the Manufacturing sector.

• The most innovative regions are “Lisboa e Vale do Tejo” and “Centro”. The “Norte” region has a share of approximately 41%, the “Alentejo” region 31% and the “Algarve” region has share of almost 16% of innovative enterprises. All present a similar magnitude in the effectiveness of innovation of more than 90%.

• The national market obtains the preference of almost 50% of the Innovating enterprises and, the International market of around 28%.

The CIS methodology proved to be an excellent instrument that provides several indicators and variables that are useful to compare data from different countries, to evaluate trends from different countries and to clarify country specifications.
But CIS does not provide information and measures of some important factors mentioned by the theories on innovation. And in many situations the need to undertake complementary analysis in order to get to clear conclusions was obvious and a more in depth look proved to be necessary (Bóia et alii, 2003).

2.5.2.2. The European Innovation Scoreboard for Portugal

Figure 2.7 illustrates the current trend in innovation performance, showing Portugal’s “catching up” position in the European Innovation Scoreboard, a truly “tableau-de-bord” of Innovation in Europe.

The picture portrays on the vertical axis the summary innovation index and on the horizontal axis the average percentage change in the trend indicators.

Source: The European Innovation Scoreboard, No. 14/2004

**Figure 2.7. Summary Innovation Index**

Figure 2.8 illustrates the previous situation (from 2001). Although some have questioned this result which could partly be due to deficient data collection at national level, the truth is that Portugal’s position at the 2001 Scoreboard was dramatic.
Figure 2.8. Innovation in Portugal in the European Context in 2001

According to the report (Cordis, 2004), Portugal is one of the best examples of a country catching up from very low base values. Compared with a similar analysis two years ago, Portugal has moved from the “falling behind” (in 2000) to the “catching up” quadrant (at the beginning of 2004).

Nevertheless, the indicators in the European Innovation Scoreboard continue to show that Portugal’s performance is rather poor compared with the European Union average. Portugal records below average levels for nearly all the indicators calculated by the European Innovation Scoreboard.

Portugal’s performance is to a large extent a consequence of structural weaknesses in the education and economic field, which will take a long time to overcome, demanding medium- to long-term policies. Portugal’s longstanding specialisation in traditional, low- and medium-technology intensive industries, characterized by low R&D levels, further contributes to the gloomy picture, since current innovation efforts in those industries is not yet reflected in the set of indicators selected. Be this as it may, Portugal’s national system of innovation is fragile and needs to be strengthened in order to enhance innovative performance and industry competitiveness. This has been recognized by the public authorities and is to some extent expressed in the design of both EU-supported programmes (the above referred POE, POCTI and POSI) and Government initiatives such as the Integrated Programme for Innovation (PROINOV) and the recently launched PPCE Programme, where there is an action line on ‘supporting innovation, research, and development’ (Cordis, 2002).

Figure 2.9 illustrates the innovation trends for Portugal, highlighting the main directions of change. Overall, Portugal seems to be catching up in five main areas: public R&D expenditure, home internet access, new science and engineering graduates, business R&D expenditure and high-tech patents.
Figure 2.9. Innovation Trend for Portugal (source: Cordis, 2002)

According to one of the most recent European Trend Charts on Innovation focusing on the analysis of national performances (Cordis, 2003), Portugal’s major relative strengths are:

- Trend for science and engineering graduates
- Trend for USPTO (United States Patent and Trademark Office) high-tech patents
- Trend for early-stage venture capital

And the major relative weaknesses are considered to be:

- Current business R&D
- Current high-tech patents
- Current patents

In short, a large potential for improvement is to be exploited but this will certainly require a large effort over a considerably long period of time.
Chapter 3. The Research Project

3.1. Introduction

This chapter briefly presents the research project jointly undertaken by OCES and INESC Porto that gave support to the present thesis. The methodology used as well as the main tasks developed in each of the project phases are described in the following sections.

The interest and experience of OCES (the institution conducting research studies in the area of innovation and economic growth in Portugal) and INESC Porto (a Portuguese leading research institute strongly involved in innovation projects) were of major relevance when establishing the research focus and the project objectives.

3.2. Methodological Framing

The initiative of OCES and INESC Porto was materialized in a research project aiming at analysing and characterizing innovation in collaborative R&D actions, in Portugal, with a special focus on product development innovation projects undertaken by alliances or partnerships between private and public institutions.

The developed methodology was dynamically redefined along the study in order to reflect the improved understanding as one went through the various research phases.

The overall research project methodology is composed of five phases:

1. Definition
2. Design and Implementation
3. Data collection
4. Data processing and analysis
5. Analysis of results

The outputs of each phase provided focus and input to the forthcoming phase. All phases were supported by a continuous process of best practice analysis through literature review, which supported the analysis and interpretation of the acquired data while consulting external specialists.

It is important to mention that a dedicated team was set to work for the first, second and third methodology phases.

1. Definition phase
During this phase, the main players, functions/roles and outputs of a PDIP were defined. A set of indicators to support the measurement or qualitative characterization of different aspects of a PDIP was also organized.
A number of relations among the defined elements was also sought.
At this stage, the sample of projects to be analysed was also selected.
Within the scope of this work, the term successful innovation applies to projects where both actual and potential success were achieved. And our understanding of successful innovation projects refers to the projects that have marketed results (results effectively put on the market), which means that the outputs obtained are recognized as a potential resource (tool) by at least one entity in the circuit of economic exchange.

2. Design and implementation phase
Based on the generic model designed on the previous phase, a questionnaire (presented, together with the supporting tables, in Annex A) was developed and prepared.

3. Data collection phase
During this phase, information was collected using a CAPI (Computer Assisted Personal Interviewing) method supported by face-to-face interviews with the respondents, the project managers of the coordinating entities of each project consortium.

4. Data processing and analysis
The data collected was processed and new specific indicators were built to measure and characterise the innovation process in PDIPs. Relations between project’s results, strategic competences and the different elements of the innovation process occurring in this type of projects were also defined.

At this stage, some corrections were made to the survey database, following to the detection of inconsistencies in the stored information.

5. Analysis of results
The results obtained were analysed. It was possible to characterize the sample and to draw some conclusions from the indicators calculated and the relations established among the different elements of the innovation process.

We have to recognize the inherent risks of this quantitative and qualitative study that aims at producing qualitative indicators supporting its conclusions. In this case, the statistical work is merely instrumental since the size of the sample is very small. For these reasons, the error checking, data correction methods commonly used in a statistical analysis do not apply in this particular case. The data collected was therefore carefully checked manually and the necessary corrections and changes were made.

3.3. Definition Phase

Taking into consideration the purpose of the present work and the explicit focus on PDIPs, the innovation process was characterised using four main elements or vectors: actors involved, functions performed, roles played and outputs.

a) Actors

The actors identified in an innovation project are the different types of entities that can be involved in a consortium undertaking a PDIP:

- **Universities**: generic name for institutions conferring an higher education degree.
• **R&D Institutes**: public or private, linked to universities or not.
• **Technology Centres**: sector-oriented or thematic.
• **Funding Institutions**: entities managing and promoting R&D and innovation funding programs, venture capitalist companies or other investors.
• **Enterprises**: among others, product and system providers (machine manufacturers, software houses, system integrators, etc.), service companies (offering consultancy, training and engineering services, etc.), technology brokers (mainly involved in technology intermediation).
• **Enterprise Associations**: regional, national or sector-oriented.

**b) Functions**

The development of a PDIP requires several functions to be performed, the most important of which were identified as (emphasizing the life-cycle of a project) following:

• **Coordination**: leadership and project management
• **Funding**: private and public financial contribution needed to support the project
• **Basic research**: experimental or theoretical work undertaken primarily to acquire new knowledge, without any particular application or use in view
• **Applied research**: original research undertaken in order to acquire new knowledge, but directed primarily towards a specific application or objective; it develops ideas into operational forms (for example prototypes), often protected through patents or other mechanisms of IPR protection
• **Development**: technology validation, product definition, specification and development
• **Marketing and Sales**: activities related to the promotion and sales of the project results
• **Maintenance and Support**: complementary activities required for an adequate life-long operation of the novel products, which need a specialized support
• **Dissemination**: novel products often need specific awareness and dissemination actions to promote their use
• **Consultancy**: specialized advices provided by experts
• **Training**: activities related with knowledge transfer, since the use of novel products often requires specialized knowledge which is to be transferred through training

The actors and functions building the PDIP generic model are usually related as illustrated in Figure 3.1. Possible allocation of functions to actors are shown.
The coordination and funding are more general functions of an essentially managerial nature. Basic research, applied research, development and consultancy are essentially technical functions that are performed mainly by universities and research and development (R&D) institutes. Except for basic research, where universities and R&D institutes usually play an important role, the other entity types can be involved in most of the remaining functions. Marketing & sales, dissemination and IPR protection are related to the commercial aspects of a PDIP, where enterprises usually have a predominant role. R&D institutes and technological centres may nevertheless play a very important role here, particularly in projects with SME's. The last group of functions (Training, Maintenance & Support and Test & Validation) is closely related with the enterprise’s activity.

c) Roles

The main roles that may be assumed by the actors involved in a product development innovation project identified are:

- Funding role
- Technology vendor
- Researcher
- Coordinator
- Developer
- End-user

---

2 U-Universities, R&D-I- Research and Development Institutes, TC-Technological Centres, E-Enterprises, EA-Enterprise Associations
Other roles could be considered for these types of projects, such as consultant, marketer or auditor. But for the sake of simplicity only the ones assumed to have very high relevance were analysed.

d) Project outputs

Considering the type of projects analysed, different outputs of a PDIP were considered: novel products, licences, associated services, patents, trademarks, scientific results, spin-offs, new business units created.

The selected sample consisted in 70 projects, but only in 50 cases the specified data was collected. One of the 50 projects was actually found to be a process innovation project, thereby reducing the sample to 49 PDIPs.

3.4. Design and Implementation Phase

The questionnaire was designed during this phase. It combines both open and closed questions. The questionnaire is available in Annex A.1 and the supporting tables in Annex A.2. The questions were answered by Yes/No (1/0) if not specified otherwise.

The questionnaire developed consists of five parts:

1. Survey Presentation
The first part contains a brief presentation of the survey, stating its objectives as well as the terms of confidentiality.

2. Introduction
The introduction contains general information on the interviewer and on the respondent. This information was collected mainly for internal use: to have the respondent contacts, for example, in order to re-check data – if necessary, and to leave special remarks.

3. Project
This section comprises 24 questions concerning the project: name, duration, budget, funding, previous collaboration of the entities involved, exploitation agreement, etc.

4. Partners
For each of the entities involved in the project there is a set of questions targeting mainly the characterization of the entity, the project manager at the entity level, the impact of the project results and the role and the functions performed both during the project and four years after. The coordinating entity of each project was asked to answer the questions on behalf of all the entities taking part in the project, i.e. was the respondent. In the case of sub-contracted entities, these were treated as partners if the project coordinator considered that adequate.

5. Results
This section aims to characterize the project results obtained: products, licences, associated services, marks, patents, scientific results, spin-offs, etc. The reasons for not having in exploitation the projects results are also asked here where applicable.
Questionnaire testing
The questionnaire was tested by the team involved in the project, and changes or improvements were made. The first interviews to the project coordinators were also very helpful in order to test and calibrate the questionnaire, making the necessary changes.

The indicators were the result of a brainstorm undertaken by the team during the definition phase. The selection of the indicators was made considering also the best practices from other innovation characterization studies. The indicators are presented in Annex C and the questions built on those indicators considered to be the most relevant ones for the scope of the project are briefly presented below. Each question has an associated number. In the following section, when describing the questionnaire, x represents a natural number (from 2 to 10) identifying the changing consortium partner.

A) Project

Basic administrative information on the project was collected (project code, acronym, name and type). The objective of the project was also an important piece of information both to characterize it and to allow further analysis of the achieved project results.

The project budget is important as a measure of the PDIP’s dimension. Based on this information, not only the total budget was calculated, but also the average budget per project and the standard deviation.

The dimension of the amount supported public funding, per project, is relevant because it measures the ability and commitment of the Government to support innovation, in particular in novel product development. This is the reason for including question no. 106, which enables us to calculate the total amount funded, the percentage of the public funding from the budget of the project, the average amount funded per project and the standard deviation.

From the data above the amount and the percentage of private funding is calculated, measuring the capacity and the ability of the entities involved to invest their own assets in innovative product development. Not only the total private funding was calculated, but also the average, the standard deviation and the percentage of private funding per project.

The number of entities involved in a PDIP is relevant for understanding the dimension and complexity of these type of projects and this justifies the question no. 108. The average number of entities involved in a project and the standard deviation are resulting indicators.

Data on national funding programs supporting science, technology and innovation are important to give an insight on government involvement through public expenditure in novel product development support. It was found relevant to calculate the total amount and average percentage funded per national program, providing a more in depth view taking into consideration the specific requirements each program places (question 109).

For similar reasons, the European funding programs financing the projects analysed are listed (question 110).
Project duration allows us to characterize type of work undertaken in the projects analysed. The average duration and standard deviations are calculated for both real and planned project durations.

In order to better characterize the target group of projects and to help us complete a Keywords List for PDIPs, the project coordinators were asked to mention three to five keywords for the project undertaken (question 116).

The number of projects having a web page was considered relevant as an indicator of the openness of the consortia and their willingness to disseminate the project partners, activities and results (question 117).

Previous collaboration was found to be a possible critical factor for successful PDIPs and this justifies questions no. 118. It would allow us to calculate the number and percentage of projects where partner had been involved in previous collaboration work (all partners, some of the partners or none of the partners).

The number of partners involved in the consortium creation, that is at project set-up, is also relevant to be compared with the number of entities actually involved in the project execution and this justifies question no. 119.

The existence of an agreement on exploitation of the project results was also considered a critical factor for successful PDIPs and this justifies question 120; this information allows us to calculate the number and percentage of projects setting up an agreement on the project’s results exploitation.

The number and percentage of projects created from roots and the same data for those that were the consequence of another project are relevant, because such cases portray specific capabilities for continuous innovation (this justifies question no. 121).

The number and percentage of projects in the analysed group that gave origin to new projects is relevant for the reasons just pointed out above and this justifies the question no. 123.

The number and percentage of projects using a dissemination or technology transfer network for making project results available is relevant to analyse the potential impact of project results and the dissemination efforts of the consortia (question no. 124).

B) Partners

Administrative information on the entities that participated in the consortium, i.e. the project partners, was collected (name, address, constitution date, CAE, SIC, turnover and exports in 2002 and employees’ training level) in order to have basic data on the entities that were part of the projects analysed. This justifies questions no x0101, x0102, x0106, x0121, x0122, x0124, x0125 and x0126-30)

The district and NUT region were also collected, with the aim of supporting a cluster analysis of the entities involved in novel product development projects (questions x0103 and x0104).
A brief description of each entity’s main activity (questions x0123, x0120) was filled in by the project managers of the coordinating entities, allowing its analysis having in mind the objective of the projects and the results obtained.

General information on the project coordinator (at entity level) was collected: name, contact phone and e-mail address. More specific data on the person who acted as project manager was also collected to facilitate a more in depth analysis: position, education level and previous experience in research or innovation projects (that justify questions x0110-12). This information was to be related with the commercial impact of the project results.

The type of entity performing project coordination was also considered a critical factor for project’s success and this justifies question no. x0105. It was possible to calculate the number and percentage of projects having as coordinator a certain entity type. Besides, the number and percentage of entity types involved in each of the projects analysed would allow us to characterize the consortium composition for each of the projects.

The distribution of roles and functions among consortia partners (taking into consideration the entity type) were considered one of the most relevant factors for project’s success and this justifies question x0113, referring to roles, and questions x0170-90, referring to functions. Concerning functions, the entity involvement in performing a certain function execution was required not only during the project but also for the four forthcoming years. In fact, many functions, such as development, marketing & sales, maintenance & support, dissemination, consultancy or test & validation only exist and/or have an higher execution level after the project ends.

The project coordinators were also asked to indicate or select the most adequate entity to perform a certain function. The “correct” fact considered relevant for a correct distribution of functions among the consortium partners had a potential to ensure an high success rate, even if this may represent a subjective point of view of the project coordinators.

Partner’s budget and funding are considered relevant to measure each entity’s expenditure (in particular the enterprise’s expenditure) - total amount and expenditure – and thus their commitment to innovation and R&D (this justifies questions x0131 and x0132).

The information concerning the creation of an internal team to be assigned to the project development is relevant to understand the importance given by each entity to the project; this justifies question no. x0135 which enables us calculate the number and percentage of projects and entities with dedicated internal teams.

The assignment of the responsibility to a member of staff of the company is relevant for the same reason as above; this justifies question no. x0136 which enables us to calculate the number and percentage of such projects.

The involvement of the project manager in innovation projects as a whole is relevant as a measure of the importance assigned (the percentage of time dedicated) to innovation and this justifies question no. x0137. The question was, unfortunately, not well understood by some of the respondents who indicated their involvement in that specific PDIP.

The direct involvement of the board of directors could be a relevant factor for the project’s success and this justifies question no. x0138, which enables us to calculate the number and percentage of such projects.
The previous experience of each entity in innovation projects is an important information: it was considered as influencing project’s success; this justifies question no. x0139 enabling us to calculate the number and percentage, per classes of analysis, where previous experience prevails.

The number and percentage of entities having a R&D department and its dimension, per entity type, is relevant to understand the importance of innovation for each entity. This justifies question no x0140 which enables us to obtain such indicators.

The indicators of impact are an attempt to evaluate or measure innovation, using information related to different aspects of company performance. The entities performing technology vendor and end-user roles were considered as having greater potential impact on the marketable project results and the questions included in the survey were applicable only to these entities. The increase in turnover is the main indicator to measure innovation impact; the increase in internal market share is relevant to measure innovation impact at national level while the increase in the external market share is the one providing information on the impact of the novel products developed on a European/global scope. An increase in the employees training level is relevant to measure the impact of innovation on human resources and knowledge. The increase in productivity is relevant to correlate with those cases where that innovation can be also the improvement of a procedure, methodology, etc. Product innovation often generates process innovation that contributes to increased efficiency.
The increase in the capability to adapt to client’s demands is relevant to evaluate the importance assigned by the entities performing end-user and technology vendor roles to market needs.
The above justifies questions x0141-47 and x0149-55.

Previous experience in the business sectors that the projects were addressing was considered a potential successful factor. Technology vendor or research were considered the most relevant roles regarding this aspect, due to the focus on product development innovations (this justifies questions x148 and x0156). Due to an implementation misunderstanding, question x0156 refers to an R&D institution and not to the entity performing researcher role.

Innovation projects can have an impact on the participating entities not only in terms of turnover, market positioning, technological level, education level, capability to adapt to client’s demands, etc., but also in terms of reinforcement or creation of R&D activities (possibly organised into new R&D units) or to the entity’s image. This justifies questions no x0x0159, x0160 and x0161. The reinforcement of the cooperation networks with the science & technology institutions is also important and justifies question x0157.

Another important aspect is the impact on each of the future activities, such as the continuation of similar activities after the project ends and this is why question x0158 was addressed.

Intellectual and industrial property rights agreements on project results were considered a potential critical factor for PDIPs, since many conflicts might be generated by the lack of ex-ante agreements in this area (this justifies questions no x0161a-x0166).

It was also found by no means relevant to analyse knowledge transfer through the mobility of employees among different types of institutions within the context of a PDIP and this justifies questions x0167-9.
C) Results

Considering the target of the research work - novel product development projects - the main results were considered to be either the end products and the licensing of the technologies or any associated services. Each of these results were intended to be analysed in terms of economic impact through the turnover generated and the first two results also as quantities. The information collected refers to the period of time of project execution as well as four subsequent years. This justifies questions 300-390. The novel products obtained considered to have a radical or incremental innovation degree and could have been introduced in the national or international market, or both.

One indicator of the character of new technology can be found in the stream of patents granted. While not each novel technology is suitable to patenting and those that are may not necessarily be representative of the whole set of project results, patents provide some interesting clues to what is happening on the frontiers of technical advance. The questions in the questionnaire refer to the number of patents and turnover generated by patents during the project and the four forthcoming years (395, 400). Information on the type of patent is also sought (to allow for the distinction between national and international patenting), justifying question no 420. The search for the reasons for not registering a patent (421) were also part of the inquiry.

Trademarks are also relevant for the protection of marketable products; this explains questions 405 and 410 inquiring the number and turnover associated to the trademarks associated with project results.

The number of spin-offs companies created and the number of new business units created with the partner companies are of highest relevance for the broader social and economic impact of the project. Such information is collected through questions no. 417 and 418.

Project results can refer not only to novel products but also to the scientific outcome. This could be measured through the increased education level of the participating human resources in science & technology areas (number of Master Thesis or PhDs – questions no 417 and 418), as well as through the scientific results (publications), which justifies question no 419.

A project may have results in exploitation or not. The objective of the project (this is the reason why the project was granted public funding) was to reach marketed results. In some of the cases however the participating entities prefer to exploit the results only for their internal use. Questions 422-453 refer to project results exploitation and the reasons for not exploiting them. Cases occur where the results are brought into exploitation in less than one year and in those cases it is relevant to know the way in which these results become commercially exploited. This justifies questions 454 and 455.

3.5. Data Collection

The Computer Assisted Personal Interview (CAPI) method was used for this survey in order to collect the data. Face-to-face interviews were used to collect the data. Most of the project coordinators that should answer the survey were from the district of Porto and it was therefore possible to minimize the travelling effort for the interviewers and thus the associated costs.
The presence of the interviewers were of invaluable help in the clarification of both questions and answers.

3.6. Data Processing and Analysis

Following to the face-to-face interviews, the data questionnaire was stored in an Access database. After further corrections, specific project indicators were built in order to measure and thus characterize the innovation process in the PDIP projects. Specific relations between the innovation project success and strategic alliances within the consortium members were also sought.

Figure 3.2 illustrates the main operational processes of the survey data management.

The operational stage comprises the following main processes:
- Construction and selection of the sample frame
- Questionnaire design and implementation, as well as preparation of work instructions
- Data collection and its coordination
- Data processing (logical checking and data editing)
- Production of final data
- Data analysis
- Publication, presentation and dissemination of final survey results
- Archiving
Figure 3.2. Main operational processes of survey data management
(adapted from Statistics Finland (43); DB - Data Base)
Chapter 4. Analysis of Results and Relations

4.1. Introduction

This chapter presents and discusses the results of the field survey.

As stated before, many of the indicators calculated by the current innovation surveys continue to have their origins in the Linear Model of innovation. Critics of the indicators associated with the Linear Model of innovation suggest that they measure only parts of the innovation process. For example, R&D expenditure and patent data underestimate non-technical forms of innovation (i.e. management or marketing changes) and underplay the application of existing knowledge from internal/external sources of innovation. Patents, meanwhile, do not give a complete picture as to whether the innovation is capable of being commercially exploited.

Many of the indicators calculated in this thesis are based on the Linear Model of innovation. Aiming at analysing other aspects of the innovation process, different relations were set among different elements that were able to offer a better understanding and a more detailed characterization of innovation in collaborative R&D projects.

The results obtained by processing the collected data allowed us to characterize the sample of PDIPs, to calculate relevant indicators and to establish meaningful and quantifiable relations among the different elements present in the analysis. The word correlation was avoided because the survey did not follow the strict rules of a statistically-based study.

This chapter is intended to provide insight in the characteristics of the survey participant entities, projects and projects results.

4.2. Indicators

4.2.1. Introduction to Sample Characterization

For an improved understanding and interpretation of the results, it is important to keep in mind a number of specificities that characterize the sample of PDIP’s analysed, the partners involved in the consortia and the actual results obtained by the projects. These specificities are briefly addressed below, providing some further insight:

• The surveys were filled in by the project manager of the coordinating entity during the interview. The interviewer’s role was to guide the interview and to assist in the interpretation of the less obvious questions. The coordinating entities were predominantly enterprises, as illustrated in Table 4.1. This fact is easy to understand, because of the underlying orientation for product development in all the projects analysed. The government financing programs also recommended, or even sometimes imposed, that the project’s prime contractor or coordinator should be an enterprise.
Table 4.1. Coordinating entities – distribution by entity type

<table>
<thead>
<tr>
<th>Entity type</th>
<th>Number of projects</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Enterprises</td>
<td>34</td>
<td>69.39 %</td>
</tr>
<tr>
<td>Technological Centers</td>
<td>6</td>
<td>12.24 %</td>
</tr>
<tr>
<td>R&amp;D Institutes</td>
<td>8</td>
<td>16.33 %</td>
</tr>
<tr>
<td>Universities</td>
<td>1</td>
<td>2.04 %</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>49</strong></td>
<td><strong>100.00 %</strong></td>
</tr>
</tbody>
</table>

Note: When calculating the percentage, the results were rounded to the nearest integer. The number of digits to round to is 2.

- The selected sample has a high number of projects with results which were considered as having commercial impact (75.51%), but it should be acknowledge that the reality is not as encouraging as it looks. In fact, since all these projects were granted with some public co-financing, they have all passed a quite narrow screening when applying for financial support. The unsound ideas and the ill-designed projects have hopefully been stopped at an early stage, as well as the projects submitted by companies which were not financially sound. Furthermore, successful projects are usually willing to provide information on their development and the project coordinators which are truly leaders do not need to hide or disguise information. Because they were much more useful in terms of the richness of the information provided, potentially successful projects lend themselves to be selected. Should the sample selection have been done in a random way, the results would certainly be less encouraging.

- Most of the entities involved are from the North Region of Portugal (around 55 %); this is explained by the fact that the manufacturing exporting SME’s, which are leading the participation in public-funded research according to (European Commission, 2003) are highly concentrated in the North of Portugal.

### 4.2.2. Characterization of the Project

The following tables and figures support the target projects characterization. The results (indicators calculated) were grouped as follows:

#### 1. Objectives

The objectives of the projects analysed refer mainly to systems, equipment, software or machine development. Considering the type of products referred to as the objective aimed to be achieved, these were grouped into three main categories: final market products, components or materials; systems, machines or equipment; and software applications. Figure 4.1 portrays the distribution by the different categories.
Figure 4.1. Projects’ objectives

2) Duration and time distribution

a) Actual duration

The average duration of the projects analysed is approximately 29 months (28.61 months) with a standard deviation of 10.96 months. The minimum duration is 11 months and the maximum project duration is 54 months. This reveals significant variation in project ambition, complexity and resources within the selected sample.

b) Planned duration

The average planned duration of the projects was 21.71 months and the standard deviation 8.62. The planned duration ranged from 9 to 48 months.

For one of the projects this information was not available, so the sample of this indicator consists of 48 projects.

c) Delays

Slightly over two months (2.35 months) is the average delay in starting a project; the standard deviation is 9.52 and the values range from 14 months and minus 10 months. The explanation for these delays can be found in the bureaucratic delays imposed by the public funding as well as in delays in the advance payments.

9.52 months is the average delay in finishing a project, with a standard deviation of 9.36 months. The values range from 33 months to minus 8 months (project that ended with 8 months earlier than it was planned).

Considering only the positive values - that is only the projects which had delays (excluding the ones that started or ended earlier), the average delay in starting the project is 6.89 months and the standard deviation is 3.97. The sample consists in this case in 19 projects.

The average delay in ending the project is in this case 11.51 months and the standard deviation 8.59.
The reasons for ending these types of projects with delays include late start, a bad planning, extra unforeseen work, etc.

d) Time distribution

The projects analysed started between 1995 and 2002 and ended between 1996 and 2003. Table 4.2 illustrates the distribution of starting and finishing dates between 1995 and 2003. Although the time-span during which the sample projects have developed may seem a bit large, this was found necessary in order to build a sufficiently large sample.

Table 4.2. Projects’ starting and ending years

<table>
<thead>
<tr>
<th>Year</th>
<th>Number of projects that started</th>
<th>ended</th>
</tr>
</thead>
<tbody>
<tr>
<td>1995</td>
<td>3</td>
<td>-</td>
</tr>
<tr>
<td>1996</td>
<td>6</td>
<td>1</td>
</tr>
<tr>
<td>1997</td>
<td>9</td>
<td>4</td>
</tr>
<tr>
<td>1998</td>
<td>10</td>
<td>5</td>
</tr>
<tr>
<td>1999</td>
<td>14</td>
<td>5</td>
</tr>
<tr>
<td>2000</td>
<td>6</td>
<td>7</td>
</tr>
<tr>
<td>2001</td>
<td>-</td>
<td>18</td>
</tr>
<tr>
<td>2002</td>
<td>1</td>
<td>7</td>
</tr>
<tr>
<td>2003</td>
<td>-</td>
<td>2</td>
</tr>
</tbody>
</table>

3) Budget and funding

a) Funding programs and their contribution

Table 4.3 illustrates the number of projects financed by each funding program. These government support programmes have been referred in Chapter 2 of the thesis.

Table 4.3. Portuguese funding programs

<table>
<thead>
<tr>
<th>National funding programs</th>
<th>Number of projects</th>
</tr>
</thead>
<tbody>
<tr>
<td>PEDIP</td>
<td>16</td>
</tr>
<tr>
<td>PRAXIS I&amp;D em Consórcio</td>
<td>15</td>
</tr>
<tr>
<td>ICPME</td>
<td>11</td>
</tr>
<tr>
<td>IMIT</td>
<td>3</td>
</tr>
<tr>
<td>POE</td>
<td>2</td>
</tr>
<tr>
<td>PRODIBETA</td>
<td>2</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>49</strong></td>
</tr>
</tbody>
</table>

Table 4.4 shows, for each of these national funding programs, the average percentage funded and non-funded and the amounts funded and not-funded. The information was available only for 46 projects; there was no information available on the IMIT program.
Table 4.4. Funding by national funding program

<table>
<thead>
<tr>
<th>National funding program</th>
<th>Average amount funded (€)</th>
<th>Average amount non-funded (€)</th>
<th>Average percentage amount funded</th>
<th>Average percentage amount not-funded</th>
</tr>
</thead>
<tbody>
<tr>
<td>PEDIP</td>
<td>204.961</td>
<td>187.884</td>
<td>52.2%</td>
<td>47.8%</td>
</tr>
<tr>
<td>PRAXIS I&amp;D em Consórcio</td>
<td>179.256</td>
<td>132.122</td>
<td>57.6%</td>
<td>42.4%</td>
</tr>
<tr>
<td>ICPME</td>
<td>259.160</td>
<td>189.499</td>
<td>57.8%</td>
<td>42.2%</td>
</tr>
<tr>
<td>POE</td>
<td>933.920</td>
<td>1,009.922</td>
<td>48.0%</td>
<td>52.0%</td>
</tr>
<tr>
<td>PRODIBETA</td>
<td>569.776</td>
<td>910.847</td>
<td>38.5%</td>
<td>61.5%</td>
</tr>
</tbody>
</table>

Note: When calculating the percentage, the results were rounded to the nearest integer. The number of digits to round to is 1.

The values presented refer to the so-called eligible expenses, i.e. the project costs that each funding program considers acceptable for public finding according to the specific laws and regulations that apply. The actual project costs may differ from these.

b) Average budget

The average value of the total project budget is 494,355.75 Euros (the values ranging from 10,714 Euros to 2,800,003 Euros). This information was available only for 46 out of 49 projects of the sample. This confirms the sample heterogeneity in what concerns the size of the projects.

c) Average funding

The average percentage of public funding in the sample is 54.52%.
The average funding is 257,094.83 Euros, with a standard deviation of 239,126 Euros.
This information was available only for 46 out of projects of the sample.

It can be observed that there is not a large variation in the percentage of public funding in the sample projects analysed.

d) European funding programs

Two of the projects analysed were co-financed, besides the Portuguese funding programs, by two European funding programs: one by IST and another by Innovation and SMEs.

4. Number of partners

a) Total and average number

A total of 151 entities (from which 94 legally distinct) were involved in the 49 projects analysed. The average number of partners per project is three (the minimum number of partners per project is 2 and the maximum is 10) and the standard deviation in the sample is 1.59. Table 4.5 portrays in more detail the frequency distribution of the number of partners in project consortia. A rather small number of projects were undertaken by consortia with five or more partners, this being the typical case given the nature of the projects.
Table 4.5. Frequency of partners per consortia

<table>
<thead>
<tr>
<th>Number of partners per consortium</th>
<th>Number of projects</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>2 partners</td>
<td>22</td>
<td>44.90 %</td>
</tr>
<tr>
<td>3 partners</td>
<td>15</td>
<td>30.61 %</td>
</tr>
<tr>
<td>4 partners</td>
<td>8</td>
<td>16.33 %</td>
</tr>
<tr>
<td>5 partners</td>
<td>1</td>
<td>2.04 %</td>
</tr>
<tr>
<td>7 partners</td>
<td>1</td>
<td>2.04 %</td>
</tr>
<tr>
<td>8 partners</td>
<td>1</td>
<td>2.04 %</td>
</tr>
<tr>
<td>10 partners</td>
<td>1</td>
<td>2.04 %</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>49</strong></td>
<td><strong>100 %</strong></td>
</tr>
</tbody>
</table>

Note: The percentages were rounded to the nearest integer. The number of digits to round to is 2.

b) Partners involved in projects’ preparation

The average number of entities involved in the actual preparation of the projects is 3 (to be more exact 2.74 entities). One may therefore assume that in merely all cases the consortium partners were involved from early project preparation.

5. Origin and follow-up

a) Consequence or follow-up from previous innovation projects

It was found that 37 projects, that is 75.51% of the total number of projects, were the direct consequence or follow-up of previous innovation projects and the remaining 12 projects (24.49 % of the total) were created from roots.

b) Creation of new projects

A total of 24 projects were leading to the creation of new projects, which represents nearly half (48.98%) of the total number of projects analysed.

These two percentages clearly indicate that one innovation project leads to the next one because consortia often keep working together with minor changes. This aspect is of particular importance because it configures the building of strategic alliances that keep their stability for long periods of time.

6. Dissemination and consortium openness

a) Dissemination networks

Four projects (8.16 % from the total number) used a dissemination network for the dissemination and technology transfer of project results. Three of these projects achieved marketed results.

The dissemination or technology transfer networks used were the two Portuguese Innovation Relays Centres, the CPI-Centro Português de Inovação for three of the projects and the IRC-ISQ for a fourth project.
The project without marketed results but which used a dissemination or technology transfer network had as only result a marketed trademark.

It appears that the great majority of the projects did not need to use dissemination networks external to the consortium. This may be explained by the fact that in these PDIPs these functions were fully undertaken internally.

b) Web page

12 projects, i.e. about one fourth (24,49%) of the total number of projects have a web page, which portrays reduced motivation in publicizing the projects and their results through this channel.

7. Previous collaboration

The level of previous collaboration among consortium members’ is illustrated in the Table 4.6.

<table>
<thead>
<tr>
<th>Previous collaboration</th>
<th>Number of projects</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>All partners</td>
<td>23</td>
<td>46.94 %</td>
</tr>
<tr>
<td>Some partners</td>
<td>14</td>
<td>28.57 %</td>
</tr>
<tr>
<td>None of the partners</td>
<td>12</td>
<td>24.49 %</td>
</tr>
<tr>
<td>Total</td>
<td>49</td>
<td>100 %</td>
</tr>
</tbody>
</table>

Note: When calculating the percentage, the results were rounded to the nearest integer.
The number of digits to round to is 2.

In more than three quarters of the projects analysed (75,51%) the consortium partners had previous collaborations (among all or only some of the partners). In almost half (46,94%) of the projects analysed, there had been previous collaboration among all consortium members.

The findings here further support what has been suggested in point 5 above on the building of strategic alliances for innovation.

8. Keywords

Based on the information collected, it was possible to construct a small keywords list enabling a more efficient browsing in the database of the analysed projects. This list is available in the Annex D.

9. Exploitation agreement

For 31 projects, which represent more than two thirds of the projects analysed (64,58%), an exploitation agreement on project results was negotiated and signed. This information was available for 48 projects.

The majority of the consortium partners have thus shown that they are aware of such an agreements as a management tool.
4.2.3. Characterization of Project Partners

The figures and tables below characterize the entities involved in the projects analysed.

1. Type and main activity sector

a) Entity type

A total of 115 entities (from which 94 were legally distinct institutions) were involved in the 49 projects analysed. Table 4.7 and Table 4.8 present the distribution of entities (the first one refers to the legally distinct entities and the second one refers to all occurrences) involved in the 49 projects analysed.

Table 4.7. Distribution of (legally distinct) entities involved in the projects analysed by type

<table>
<thead>
<tr>
<th>Entity type</th>
<th>Number of entities</th>
<th>Percentage of entities</th>
</tr>
</thead>
<tbody>
<tr>
<td>Enterprises</td>
<td>60</td>
<td>63.83 %</td>
</tr>
<tr>
<td>Enterprise Associations</td>
<td>2</td>
<td>2.13 %</td>
</tr>
<tr>
<td>Technological Centers</td>
<td>5</td>
<td>5.32 %</td>
</tr>
<tr>
<td>R&amp;D Institutes</td>
<td>14</td>
<td>14.89 %</td>
</tr>
<tr>
<td>Universities</td>
<td>13</td>
<td>13.83 %</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>94</strong></td>
<td><strong>100 %</strong></td>
</tr>
</tbody>
</table>

Note: The percentages were rounded to the nearest integer. The number of digits to round to is 2.

Table 4.8. Distribution of all entities involved in the projects analysed

<table>
<thead>
<tr>
<th>Entity type</th>
<th>Number of entities</th>
<th>Percentage of entities</th>
</tr>
</thead>
<tbody>
<tr>
<td>Enterprises</td>
<td>77</td>
<td>51.00 %</td>
</tr>
<tr>
<td>Enterprise Associations</td>
<td>2</td>
<td>1.32 %</td>
</tr>
<tr>
<td>Technological Centers</td>
<td>15</td>
<td>9.93 %</td>
</tr>
<tr>
<td>R&amp;D Institutes</td>
<td>43</td>
<td>28.48 %</td>
</tr>
<tr>
<td>Universities</td>
<td>14</td>
<td>9.27 %</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>151</strong></td>
<td><strong>100 %</strong></td>
</tr>
</tbody>
</table>

Note: The percentages were rounded to the nearest integer. The number of digits to round to is 2.

Enterprises and R&D Institutes dominate the consortia in PDIP’s. Technological Centres and Universities are also relevant actors. The presence of Enterprise Associations is marginal.

b) Main activity sectors

The partners involved covered rather well the main activity sectors of the economy. Considering the first two digits of the Economic Activity Classification (CAE), the activity sectors of the distinct entities involved in the projects analysed are listed in Table 4.9. For three foreign institutions it was not possible to obtain this information.
Table 4.9. Distribution of the distinct entities involved in the projects analysed according to the activity sectors

<table>
<thead>
<tr>
<th>CAE (first two digits)</th>
<th>Activity sector description</th>
<th>Number of entities</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>17</td>
<td>Textiles manufacturing</td>
<td>1</td>
<td>1.1%</td>
</tr>
<tr>
<td>18</td>
<td>Clothing industry, preparation, dyeing</td>
<td>1</td>
<td>1.1%</td>
</tr>
<tr>
<td>19</td>
<td>Leather articles without coat, cutting and travel articles manufacturing</td>
<td>4</td>
<td>4.4%</td>
</tr>
<tr>
<td>20</td>
<td>Cork and wood industry</td>
<td>2</td>
<td>2.2%</td>
</tr>
<tr>
<td>22</td>
<td>Edition, printing and reproduction of recorded information</td>
<td>1</td>
<td>1.1%</td>
</tr>
<tr>
<td>24</td>
<td>Chemical products manufacturing</td>
<td>2</td>
<td>2.2%</td>
</tr>
<tr>
<td>28</td>
<td>Metal products manufacturing (except machines and equipment)</td>
<td>3</td>
<td>3.3%</td>
</tr>
<tr>
<td>29</td>
<td>Machines and equipment manufacturing</td>
<td>13</td>
<td>14.28%</td>
</tr>
<tr>
<td>31</td>
<td>Machines and electronic devices</td>
<td>4</td>
<td>4.4%</td>
</tr>
<tr>
<td>32</td>
<td>Radio, television and communication devices and equipment manufacturing</td>
<td>3</td>
<td>3.3%</td>
</tr>
<tr>
<td>33</td>
<td>Medical-chirurgic, orthopaedic instruments and devices manufacturing</td>
<td>5</td>
<td>5.49%</td>
</tr>
<tr>
<td>45</td>
<td>Construction</td>
<td>3</td>
<td>3.3%</td>
</tr>
<tr>
<td>51</td>
<td>Wholesale and commercial agents trading, except transport vehicles and motor-cycles</td>
<td>3</td>
<td>3.3%</td>
</tr>
<tr>
<td>52</td>
<td>Retail trading; personal and domestic goods reparation</td>
<td>1</td>
<td>1.1%</td>
</tr>
<tr>
<td>60</td>
<td>Terrestrial transport; transport by pipe-lines</td>
<td>5</td>
<td>5.49%</td>
</tr>
<tr>
<td>72</td>
<td>Informatics and connected activities</td>
<td>2</td>
<td>2.2%</td>
</tr>
<tr>
<td>73</td>
<td>Research and development</td>
<td>12</td>
<td>13.17%</td>
</tr>
<tr>
<td>74</td>
<td>Other activities and services performed by enterprises</td>
<td>9</td>
<td>9.89%</td>
</tr>
<tr>
<td>80</td>
<td>Education</td>
<td>13</td>
<td>14.28%</td>
</tr>
<tr>
<td>91</td>
<td>Diverse associated activities, n.e.</td>
<td>4</td>
<td>4.4%</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td></td>
<td><strong>91</strong></td>
<td><strong>100 %</strong></td>
</tr>
</tbody>
</table>

Note: When calculating the percentage, the results were rounded to the nearest integer. The number of digits to round to is 2.

2. Turnover and volume of exports

a) Turnover

The average turnover of the entities involved (exception made to the universities for which this number would be meaningless) was 14 911,341 Euros, the information being available for the year 2002, the values ranging between 180 000 Euros and 158 237 Euros. This analysis refers to a subset of only 54 entities for which it was possible to collect this information.

Considering only the enterprises, the average turnover obtained is 18 049 834 Euros, the values ranging from 180 000 Euros to 158 237 000 Euros. The information was available only for 41 enterprises, which represents around half of the number of enterprises involved (53.25%).
The enterprise size ranges from micro-enterprises to medium-to-large companies, with SME’s dominating the sample.

b) Volume of exports

The average volume of exports for the year 2002 was 22,610,660,78 Euros, the values ranging from 863,065,000 Euros to 3,974 Euros. This data was provided by 51 entities (14 R&D institutes, 35 enterprises and 2 technological centres) and it refers to the year 2002.

Considering only the enterprises, the average volume of exports for the year 2002 is 32,743,824,57 Euros, the values ranging from 863,065,000 Euros to 4,987 Euros. The sample consists in this case of 35 enterprises, which is less than half from the total number of enterprises involved in the projects analysed.

3. Human Resources

a) Entity and enterprise size

Table 4.10 shows that most of the partners were entities of small or medium size in what concerns the number of employees.

<table>
<thead>
<tr>
<th>Number of employees</th>
<th>Number of entities</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Less than 10 employees</td>
<td>12</td>
<td>20 %</td>
</tr>
<tr>
<td>Between 10 and 49 employees</td>
<td>16</td>
<td>26.67 %</td>
</tr>
<tr>
<td>Between 50 and 99 employees</td>
<td>15</td>
<td>25 %</td>
</tr>
<tr>
<td>Between 100 and 149 employees</td>
<td>2</td>
<td>3,33 %</td>
</tr>
<tr>
<td>Between 150 and 199 employees</td>
<td>5</td>
<td>8,33 %</td>
</tr>
<tr>
<td>Between 200 and 249 employees</td>
<td>1</td>
<td>1,67 %</td>
</tr>
<tr>
<td>Between 250 and 499 employees</td>
<td>5</td>
<td>8,33 %</td>
</tr>
<tr>
<td>Between 500 and 999 employees</td>
<td>2</td>
<td>3,33 %</td>
</tr>
<tr>
<td>Between 1000 and 1499 employees</td>
<td>1</td>
<td>1,67 %</td>
</tr>
<tr>
<td>More than 1500 employees</td>
<td>1</td>
<td>1,67 %</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>60</strong></td>
<td><strong>100 %</strong></td>
</tr>
</tbody>
</table>

Note: When calculating the percentage, the results were rounded to the nearest integer. The number of digits to round to is 2.

Analysing only the enterprises (the results are listed in Table 4.11) the scenario referred to above does not change. This information was available only for 44 enterprises.
Table 4.11. Enterprise size regarding human resources

<table>
<thead>
<tr>
<th>Number of employees</th>
<th>Number of entities</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Less than 10 employees</td>
<td>10</td>
<td>22.73 %</td>
</tr>
<tr>
<td>Between 10 and 49 employees</td>
<td>11</td>
<td>25 %</td>
</tr>
<tr>
<td>Between 50 and 99 employees</td>
<td>11</td>
<td>25 %</td>
</tr>
<tr>
<td>Between 100 and 149 employees</td>
<td>1</td>
<td>2.27 %</td>
</tr>
<tr>
<td>Between 150 and 199 employees</td>
<td>3</td>
<td>6.83 %</td>
</tr>
<tr>
<td>Between 200 and 249 employees</td>
<td>1</td>
<td>2.27 %</td>
</tr>
<tr>
<td>Between 250 and 499 employees</td>
<td>4</td>
<td>9.09 %</td>
</tr>
<tr>
<td>Between 500 and 999 employees</td>
<td>1</td>
<td>2.27 %</td>
</tr>
<tr>
<td>Between 1000 and 1499 employees</td>
<td>1</td>
<td>2.27 %</td>
</tr>
<tr>
<td>More than 1500 employees</td>
<td>1</td>
<td>2.27 %</td>
</tr>
<tr>
<td>Total</td>
<td>44</td>
<td>100 %</td>
</tr>
</tbody>
</table>

Note: When calculating the percentage, the results were rounded to the nearest integer. The number of digits to round to is 2.

One striking observation if that almost 3 over 4 companies (72.73%) have less than 100 employees. One of the reasons is the fact that “medium-to-high” technology companies prevail in the sample over the “low-tech” labour-intensive ones.

But, this also explains one of the major difficulties of innovative industrial companies in having access to resources and funding granting them the technology they need: they are rather small.

On the other hand, these results are in agreement with the EC key figures 2003-2004 that states that SME’s lead in the participation in public-funded innovation projects (European Commission, 2003).

b) Average number of employees per partner

The average number of employees of the entities involved in the projects analysed is 139 persons, the values ranging from 2 to 1680 employees. This information was available only for 60 entities. Taking into consideration the small representation, a more in depth analysis was not made. Considering only the enterprises, 147 employees is the average number of employees per enterprise, the values ranging from 2 to 1680 employees. This information was only available for 44 of the enterprises.

c) Employees’ education level

The education level of the employees of the entities involved is illustrated in Table 4.12. This information was collected from 118 entities. The universities were not included in this analysis as their data would not be meaningful for direct comparison.

The education level of the 60 enterprises subset is rather high when compared with the average of the Portuguese enterprises: in average, almost all of them gave one M.Sc. and almost one in five has one PhD.
Table 4.12. Education level per entity type

<table>
<thead>
<tr>
<th>Entity type</th>
<th>Number of entities</th>
<th>Education level</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Basic School</td>
</tr>
<tr>
<td>Enterprise</td>
<td>60</td>
<td>3295</td>
</tr>
<tr>
<td>R&amp;D Institute</td>
<td>41</td>
<td>149</td>
</tr>
<tr>
<td>Technological Centers</td>
<td>15</td>
<td>48</td>
</tr>
<tr>
<td>Enterprise Associations</td>
<td>2</td>
<td>14</td>
</tr>
<tr>
<td>Total</td>
<td>118</td>
<td>3506</td>
</tr>
</tbody>
</table>

d) Employees contracted

During the project execution, 50 employees were hired by 38 partners (these represent 26.76 % of the total number of partners involved in the projects analysed, for which this information was available – 142 partners).

In four of these projects, four employees were contracted from other partners involved in the same project. All employee transfers were made from R&D institutes to enterprises, showing evidence of the way in which R&D institutes complement enterprises’ activities – providing expertise and access to experts in the areas required by the enterprises and with which they are not very familiar.

These transfers of employees can certainly be seen as technology transfers within the consortia.

4. Project coordinator

a) Project coordinator average level of involvement

The average level of involvement of the project managers, per project, is 28.66 % and the standard deviation is 17.98.

The average level of involvement of the project manager for the projects with marketed results is marginally higher (29.34 %) and the standard deviation is 19.36.

For the projects without marketed results the average level of involvement, per project, for the project managers of the entities involved is slightly smaller: 26.15 % and the standard deviation is 11.19.

The average level of involvement of the project manager of the coordinating entity is considerably high (37.8 %), and the standard deviation is 25.02.

As it was not possible to obtain this information for one of the projects, the sample size was reduced to 48 projects.

It is important to mention also that this question was not well understood by the respondents. The intention was to know the percentage of time dedicated to innovation, but when collecting this information, some of the interviewers asked for the percentage of involvement in the specific project.
b) Previous experience of the project manager of the coordinating entity in innovation projects

A total of 40 project managers of the coordinating entities had previous experience in innovation projects, this number representing 83.33% of the total number of projects where this information was available. The information was not provided by one of the project managers, thereby reducing the sample in this case to 48 projects.

c) Education level of the project manager of the coordinating entity

Table 4.13 portrays project’s manager of the coordinating entity education level. The information was available only for 48 projects.

<table>
<thead>
<tr>
<th>Project coordinator’s education level</th>
<th>Number of projects</th>
<th>Percentage of projects</th>
</tr>
</thead>
<tbody>
<tr>
<td>Basic education</td>
<td>3</td>
<td>6.25%</td>
</tr>
<tr>
<td>Bachelor degree/License</td>
<td>32</td>
<td>66.67%</td>
</tr>
<tr>
<td>Master degree</td>
<td>6</td>
<td>12.5%</td>
</tr>
<tr>
<td>PhD degree</td>
<td>7</td>
<td>14.58%</td>
</tr>
<tr>
<td>Total</td>
<td>48</td>
<td>100%</td>
</tr>
</tbody>
</table>

Note: When calculating the percentage, the results were rounded to the nearest integer. The number of digits to round to is 2.

For two thirds of the projects (66.67%), the project’s manager of the coordinating entity education level was bachelor or license degree.

d) Position of the project manager of the coordinating entity

Table 4.14 illustrates project’s manager (of the coordinating entity) position within the entity that was coordinating the project.

Half of the project managers were at the level of director in the entity being project coordinator. This fact shows evidence of the importance assigned to the project by each coordinating entity.
Table 4.14. Project coordinator’s position within the coordinating entity

<table>
<thead>
<tr>
<th>Project coordinator’s position</th>
<th>Number of projects</th>
<th>Percentage of projects</th>
</tr>
</thead>
<tbody>
<tr>
<td>Director (various types)</td>
<td>23</td>
<td>50%</td>
</tr>
<tr>
<td>Responsible within the area</td>
<td>7</td>
<td>15.22%</td>
</tr>
<tr>
<td>Administrator (Member of the Board)</td>
<td>4</td>
<td>8.7%</td>
</tr>
<tr>
<td>Owner-manager</td>
<td>4</td>
<td>8.7%</td>
</tr>
<tr>
<td>Special project coordinator</td>
<td>2</td>
<td>4.35%</td>
</tr>
<tr>
<td>Manager</td>
<td>2</td>
<td>4.35%</td>
</tr>
<tr>
<td>President of the Board of Directors</td>
<td>1</td>
<td>2.17%</td>
</tr>
<tr>
<td>Shareholder</td>
<td>1</td>
<td>2.17%</td>
</tr>
<tr>
<td>Researcher</td>
<td>1</td>
<td>2.17%</td>
</tr>
<tr>
<td>Shareholder-manager</td>
<td>1</td>
<td>2.17%</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>46</strong></td>
<td><strong>100%</strong></td>
</tr>
</tbody>
</table>

Note: When calculating the percentage, the results were rounded to the nearest integer. The number of digits to round to is 2.

5. Origin and continuity

a) Role in project creation

Table 4.15 illustrates the number and percentage of entities involved in the creation of the project (animator) and of those associated during project execution or right before the project started.

This information was available for 146 entities.

Table 4.15. Engagement in project creation per type of entity (No.-Number; P.-Percentage)

<table>
<thead>
<tr>
<th>Entity type</th>
<th>Number of entities</th>
<th>Entities involved in project creation</th>
<th>Entities associated later</th>
<th>Information not available</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>No.</td>
<td>P.</td>
<td>No.</td>
</tr>
<tr>
<td>Universities</td>
<td>14</td>
<td>7</td>
<td>50 %</td>
<td>6</td>
</tr>
<tr>
<td>R&amp;D Institutes</td>
<td>43</td>
<td>25</td>
<td>58.14 %</td>
<td>17</td>
</tr>
<tr>
<td>Technological Centers</td>
<td>15</td>
<td>12</td>
<td>80 %</td>
<td>3</td>
</tr>
<tr>
<td>Enterprises</td>
<td>77</td>
<td>44</td>
<td>57.14 %</td>
<td>30</td>
</tr>
<tr>
<td>Enterprise Associations</td>
<td>2</td>
<td>2</td>
<td>100 %</td>
<td>0</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>151</strong></td>
<td><strong>90</strong></td>
<td>-</td>
<td><strong>56</strong></td>
</tr>
</tbody>
</table>

Note: When calculating the percentage, the results were rounded to the nearest integer. The number of digits to round to is 2.

The very high tendency of technological centres to be involved right from the start in project creation should be emphasized.

Almost 60 % (59.6%) of the total number of entities involved in the projects analysed were animator in project creation. Among them, technological centres were the entity type with the highest percentage (80 %) of occurrences.

Enterprises and R&D institutes are dominant in PDIP’s: both at the project creation stage and at project run-time.
b) Involvement in similar projects after the project ended

Table 4.16 illustrates the number and percentage of entities (per type of entity) that become involved in similar projects after the project ends. The sample consists in 147 partners.

Table 4.16. Distribution of entities involved in similar projects (number and percentage)

<table>
<thead>
<tr>
<th>Entity type</th>
<th>Number of entities</th>
<th>Number and percentage of entities involved in similar projects</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Number</td>
<td>Percentage</td>
<td>Yes</td>
</tr>
<tr>
<td>Universities</td>
<td>13</td>
<td>7</td>
<td>53.85 %</td>
<td>6</td>
</tr>
<tr>
<td>R&amp;D Institutes</td>
<td>43</td>
<td>35</td>
<td>81.4%</td>
<td>8</td>
</tr>
<tr>
<td>Technological Centers</td>
<td>15</td>
<td>13</td>
<td>86.67%</td>
<td>2</td>
</tr>
<tr>
<td>Enterprises</td>
<td>74</td>
<td>42</td>
<td>56.76%</td>
<td>32</td>
</tr>
<tr>
<td>Enterprise Associations</td>
<td>2</td>
<td>0</td>
<td>0%</td>
<td>2</td>
</tr>
<tr>
<td>Total</td>
<td>147</td>
<td>97</td>
<td>65.99%</td>
<td>50</td>
</tr>
</tbody>
</table>

Note: When calculating the percentage, the results were rounded to the nearest integer. The number of digits to round to is 2.

Nearly two thirds of the entities (65.99%) involved in the projects analysed for which information was available had participated in similar projects after the project ended. The highest percentages are observed in the case of technological centres and R&D institutes (86.67% and 81.4% respectively).

Only 147 entities answered to this question (3 enterprises and one university did not answer this question).

6. Functions

a) Number per entity type

Table 4.17 and Figure 4.2 illustrate the total number of functions performed by each entity type during the project execution. The answers collected refer to three different levels of involvement (very high, medium and no involvement). Table 4.17 and Figure 4.2 comprise information for the first two of the categories that is very high and medium involvement in the project.
Table 4.17. Total number of functions performed, per entity type

<table>
<thead>
<tr>
<th>Function</th>
<th>University</th>
<th>R&amp;D Institute</th>
<th>Technological Centre</th>
<th>Enterprise</th>
<th>Enterprise Association</th>
</tr>
</thead>
<tbody>
<tr>
<td>Coordination</td>
<td>8</td>
<td>22</td>
<td>9</td>
<td>53</td>
<td>2</td>
</tr>
<tr>
<td>Funding</td>
<td>5</td>
<td>22</td>
<td>10</td>
<td>66</td>
<td>2</td>
</tr>
<tr>
<td>Basic Research</td>
<td>12</td>
<td>21</td>
<td>0</td>
<td>15</td>
<td>0</td>
</tr>
<tr>
<td>Applied Research</td>
<td>13</td>
<td>38</td>
<td>12</td>
<td>42</td>
<td>0</td>
</tr>
<tr>
<td>Development</td>
<td>12</td>
<td>39</td>
<td>15</td>
<td>56</td>
<td>0</td>
</tr>
<tr>
<td>Marketing &amp; Sales</td>
<td>1</td>
<td>8</td>
<td>8</td>
<td>35</td>
<td>0</td>
</tr>
<tr>
<td>Maintenance &amp; Support</td>
<td>3</td>
<td>21</td>
<td>9</td>
<td>39</td>
<td>0</td>
</tr>
<tr>
<td>Dissemination</td>
<td>10</td>
<td>32</td>
<td>14</td>
<td>49</td>
<td>2</td>
</tr>
<tr>
<td>Consultancy</td>
<td>8</td>
<td>28</td>
<td>10</td>
<td>23</td>
<td>0</td>
</tr>
<tr>
<td>Training</td>
<td>8</td>
<td>19</td>
<td>8</td>
<td>30</td>
<td>0</td>
</tr>
<tr>
<td>Demonstration</td>
<td>6</td>
<td>27</td>
<td>12</td>
<td>52</td>
<td>2</td>
</tr>
<tr>
<td>Test &amp; Validation</td>
<td>7</td>
<td>33</td>
<td>13</td>
<td>62</td>
<td>2</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>93</strong></td>
<td><strong>310</strong></td>
<td><strong>120</strong></td>
<td><strong>522</strong></td>
<td><strong>10</strong></td>
</tr>
</tbody>
</table>

Figure 4.2. Distribution of functions per entity type

It comes out clearly that enterprises and R&D institutes are allocated the great majority of functions in the projects analysed.

b) Fitness for the function

The project managers of the coordinating entities were asked to indicate the degree of adequacy of a certain type of entity in performing each of the functions for all entities participating in the project.
Only the entities pointed by the project managers of the coordinating entities as having an high level of involvement were considered in this analysis. Figures 4.3, 4.4, 4.5 and 4.6 present the results obtained, the differences among them being due to the different coordinating entities acting as project coordinator. The sample consists of 48 projects.

All figures below illustrate the types of entities indicated as the most adequate ones to perform a certain function, representing the point of view of the project manager of the coordinating entities. There was one project where the coordinating entity was an university, 34 projects were the coordinating entities were enterprises, six projects having technological centres as coordinating entities and eight projects having an R&D institute as project coordinator.

Figure 4.3. Adequacy of entities to functions – university as project coordinator (1 project)
Figure 4.4. Adequacy of entities to functions – enterprise as project coordinator (34 projects)

Figure 4.5. Adequacy of entities to functions – technological centre as project coordinator (6 projects)
Figure 4.6. Adequacy of entities to functions – R&D institute as project coordinator (8 projects)

The point of view of the project manager of the coordinating entity refers only to the type of entities involved in the project in question. This is a limitation, since a more in depth analysis could have been made if the answers would have comprised information on all entity types.

As general remark, the coordinating entities frequently consider themselves as the most adequate type of entity to perform a certain function. The result is some mismatch when looking at the various figures.

When analysing the survey information regarding the most adequate entity to perform a given function with the highest level of involvement and effectiveness (Figure 4.7), enterprises were indicated the most adequate type of entities to perform functions such as project coordination, funding, development, marketing & sales, maintenance & support, demonstration and test & validation.
Figure 4.7. Level of adequacy of each entity to perform each of the project functions ("fitness for function")

It is important to emphasize that these results stem from the information collected during the interview, i.e. they represent solely the point of view of the project manager of the coordinating entity (that were mainly enterprises), with the inherent subjectivity. This respondent was however the most adequate person to put forward a relevant opinion.

R&D institutes were indicated to be the most adequate entities to undertake functions such as basic research, applied research, consultancy, training and IPR protection.

Universities clearly rate lower than R&D institutes, even when basic and applied research are considered. It should be again emphasized that this emerges from an enterprise project manager's opinion and that the relations between industry and academia in Portugal have been preferably established through R&D institutes, most of which are actually university interfacing institutions where the university researchers may develop their work.
The figure also illustrates how R&D institutes, universities and technological centres complement the enterprise’s activities. Enterprise’s involvement is increasing from basic research to applied research and to development. Product development seems to be adequately performed by enterprises with the help of R&D institutes. University’s and R&D institute’s activity is decreasing from basic research to applied research and development. Technological centres have relevant roles in consultancy, training and IPR Protection.

The analysis of this information has to take into account the type of entity being project coordinator, which are mostly enterprises (69.39%).

Due to this fact, one has considered that it is not very suitable to make any further quantitative analysis. A similar qualitative analysis is based on the importance or level of adequacy assigned by each partner to each of the entity types. Table 4.18 presents the integrated view of all respondents (the project managers of the coordinating entities) on the “fitness for the function” of each entity type participating in the project.

**Table 4.18. “Fitness of the function” or level of adequacy of the entity types to the various PDIP functions (U - University, RDI - R&D Institute, TC - Technological Centre, E - Enterprise, AE - Enterprise Association)**

<table>
<thead>
<tr>
<th>Function</th>
<th>Fitness for the function</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1st</td>
</tr>
<tr>
<td>Coordination</td>
<td>E</td>
</tr>
<tr>
<td>Funding</td>
<td>TC</td>
</tr>
<tr>
<td>Basic Research</td>
<td>RDI</td>
</tr>
<tr>
<td>Applied Research</td>
<td>E</td>
</tr>
<tr>
<td>Development</td>
<td>E</td>
</tr>
<tr>
<td>Marketing &amp; Sales</td>
<td>E</td>
</tr>
<tr>
<td>Maintenance &amp; Support</td>
<td>E</td>
</tr>
<tr>
<td>Dissemination</td>
<td>E</td>
</tr>
<tr>
<td>Consultancy</td>
<td>RDI</td>
</tr>
<tr>
<td>Training</td>
<td>RDI</td>
</tr>
<tr>
<td>RPI Protection</td>
<td>RDI</td>
</tr>
<tr>
<td>Demonstration</td>
<td>RDI</td>
</tr>
<tr>
<td>Test &amp; Validation</td>
<td>E</td>
</tr>
</tbody>
</table>

These results were obtained by ordering the scores for the fitness of the function for the entity type assigned by each project coordinator.

The results obtained are inevitably influenced by the structure of the consortium. The point of view of the coordinating entity type was restricted to the entity types that were part of that particular consortium. (i.e. if, within a consortium, there were only R&D institutes and enterprises, the coordinator would not be able to state his/her opinion on universities or technological centres). Only the entities with the highest level of adequacy were considered.

Nevertheless, it comes out clearly that enterprises and R&D institutes seem to be dominating the “fitness for function” in the PDIP’s analysed.
c) Total number of functions performed during the project

Table 4.19 shows the total and the average number of functions performed by each entity type during the project, with very high and medium levels of involvement.

<table>
<thead>
<tr>
<th>Entity type</th>
<th>Number of functions performed</th>
<th>Number of entities</th>
<th>Average number of functions performed by entity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Universities</td>
<td>94</td>
<td>14</td>
<td>6.71</td>
</tr>
<tr>
<td>R&amp;D Institutes</td>
<td>314</td>
<td>43</td>
<td>7.3</td>
</tr>
<tr>
<td>Technological Centres</td>
<td>128</td>
<td>15</td>
<td>8.53</td>
</tr>
<tr>
<td>Enterprises</td>
<td>528</td>
<td>77</td>
<td>6.86</td>
</tr>
<tr>
<td>Enterprise Associations</td>
<td>10</td>
<td>2</td>
<td>5</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>1074</strong></td>
<td><strong>151</strong></td>
<td><strong>7.11</strong></td>
</tr>
</tbody>
</table>

The average number of functions performed by each entity of a certain type is quite high. One should however consider that the 13 functions of Table 4.19 do not all always occur in the same project and even if this is the case they are to be performed in different project phases. Besides that, the high number is due to the fact that very often the functions are shared among different consortium partners, this giving strong evidence of their complementarities.

d) Projects covering all functions

There are only four projects where all possible functions are covered: this represents only 8.16% of the total number of projects.

This finding fully supports the above analysis on the average number of functions performed by each entity type.

e) Functions performance during the project and the four forthcoming years

The figures from Annex E show the evolution of function execution during the project and four forthcoming years. In Annex E.1 the functions performed with medium and high level of involvement are illustrated; Annex E.2 portrays the functions performed only with high level of involvement.

Analyzing the functions performed with both very high and medium levels of involvement one can say that functions such as: coordination, funding, basic research, applied research, development, consultancy, training, demonstration, test & validation are more actively performed only during the project; marketing & sales, maintenance & support and IPR protection are more intensively performed during the four forthcoming years.

7. Roles

Distribution of Roles

Figure 4.8 illustrates the distribution of the major roles in the projects analysed, clearly showing the relative weight of the various entity types as consortia partners.
Several entities performed other less frequent roles, such as consultancy (one university and six enterprises), product commercialisation and production (two enterprises), support in equipment certification (one technology centre), industry sector representation (one enterprise association), prototype production (one enterprise) and equipment production for the pilot installation (one enterprise). In one of the projects, enterprise associations were assigned the end-user role.

The researcher role is performed mainly by R&D institutes, which play also an important part in product development, a role were they seem to partner rather well with enterprises. Besides product developer, enterprises have the most relevant contribution in performing technology vendor, end-user and project coordinator roles.

8. Previous experience in innovation projects

a) Previous experience in innovation projects

Consortium members’ previous experience in innovation projects is illustrated in the Table 4.20. It comes out clearly that the vast majority of the consortia benefited from the experience gained in previous innovation projects.
Table 4.20. Consortium members’ previous experience in innovation projects

<table>
<thead>
<tr>
<th>Previous experience in R&amp;D projects</th>
<th>Number of projects</th>
<th>Percentage from the total number of projects</th>
</tr>
</thead>
<tbody>
<tr>
<td>More than 11 projects</td>
<td>58</td>
<td>38.41 %</td>
</tr>
<tr>
<td>Between 6 and 10 projects</td>
<td>7</td>
<td>4.63 %</td>
</tr>
<tr>
<td>Between 1 and 5 projects</td>
<td>66</td>
<td>43.71 %</td>
</tr>
<tr>
<td>No previous experience</td>
<td>20</td>
<td>13.25 %</td>
</tr>
<tr>
<td>Total</td>
<td>151</td>
<td>100 %</td>
</tr>
</tbody>
</table>

Note: When calculating the percentage, the results were rounded to the nearest integer. The number of digits to round to is 2.

b) Previous experience in innovation projects per entity type

Table 4.21 illustrates consortium members’ previous experience in innovation projects, per entity types. It was possible to collect information from all entities.

Table 4.21. Consortium members’ previous experience in innovation projects, per entity type (N – Number; P - Percentage)

<table>
<thead>
<tr>
<th>Previous experience in innovation projects</th>
<th>No. of entities</th>
<th>Number and percentage of entities per entity type</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>No P</td>
<td>University</td>
</tr>
<tr>
<td>More than 11 projects</td>
<td>58 5 36%</td>
<td>29 67%</td>
</tr>
<tr>
<td>Between 6 and 10 projects</td>
<td>7 1 7%</td>
<td>3 7%</td>
</tr>
<tr>
<td>Between 1 and 5 projects</td>
<td>66 6 43%</td>
<td>11 26%</td>
</tr>
<tr>
<td>Without experience</td>
<td>20 2 14%</td>
<td>0 0%</td>
</tr>
<tr>
<td>Total</td>
<td>151 14 100%</td>
<td>43 100%</td>
</tr>
</tbody>
</table>

Note: When calculating the percentage, the results were rounded to the nearest integer. The number of digits to round to is 0.

All the R&D institutes and technological centres had previous experience in innovation projects, while enterprise associations did not have experience at all. For 21% of the enterprises this was their first innovation project; the same was true for 14% of the universities.

9. R&D department

a) Entities with R&D department

The existence of an R&D department in the participating enterprises is illustrated in Table 4.22. The enterprises are grouped by the different activity sectors according to their CAE. For two of them the information was not available. The sample is in this case of 75 enterprises. One of the 75 enterprises did not enter its activity sector, which was left blank in the table.
Table 4.22. Enterprises’ R&D department – analysis per activity sector

<table>
<thead>
<tr>
<th>Activity sector</th>
<th>Number of enterprises</th>
<th>Number of enterprises</th>
<th>Percentage of enterprises</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>With R&amp;D department</td>
<td>With R&amp;D department</td>
<td></td>
</tr>
<tr>
<td></td>
<td>with more than 11</td>
<td>with 6 to 10 persons</td>
<td>with less than 5 persons</td>
</tr>
<tr>
<td>74</td>
<td>9</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>72</td>
<td>2</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>60</td>
<td>5</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>52</td>
<td>1</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>51</td>
<td>3</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>45</td>
<td>2</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>33</td>
<td>5</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>32</td>
<td>5</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>31</td>
<td>5</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>29</td>
<td>23</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>28</td>
<td>3</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>24</td>
<td>1</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>22</td>
<td>1</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>20</td>
<td>3</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>19</td>
<td>5</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>18</td>
<td>1</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>19</td>
<td>1</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Total</td>
<td>75</td>
<td>8</td>
<td>5</td>
</tr>
</tbody>
</table>

Note: When calculating the percentage, the results were rounded to the nearest integer. The number of digits to round to is 2.
Please refer to sector activity in Table 4.9 (page 54).

More than half of the enterprises claim that they have an R&D department. The activity sectors that are stronger in this indicator are the ones with CAE 74 (Other activities and services performed by enterprises), 31 (Machines and electronic devices) and 32 (Radio, television and communication devices and equipment manufacturing), 28 (Metal products manufacturing, except machines and equipment) and 20 (Cork and wood industry).

A negative observation may fall on enterprises in sectors in with CAE 33 (Medical-chirurgical, orthopaedic instruments and devices manufacturing) and 19 (Leather articles without coat, cutting and travel articles manufacturing).
For the remaining activity sectors no special observations are to be done.

b) Partners with/without R&D department

Table 4.23 illustrates the number of entities, per type of entity, with R&D department. Universities and R&D institutes were not included since it is understood they should include such departments and the question in the inquiry would not make sense for them.

The technology centres claim having their “own R&D departments” (more than 90% of these centres, whose mission does not include R&D), although these may be just very high quality laboratories.
Table 4.23. Entities with or without R&D department

<table>
<thead>
<tr>
<th>Entity type</th>
<th>Number of entities</th>
<th>With R&amp;D department</th>
<th>Without R&amp;D department</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Number</td>
<td>Percentage</td>
<td>Number</td>
</tr>
<tr>
<td>Technological Centres</td>
<td>15</td>
<td>14</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td></td>
<td>93.33 %</td>
<td></td>
</tr>
<tr>
<td>Enterprise Associations</td>
<td>2</td>
<td>0</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td></td>
<td>0 %</td>
<td></td>
</tr>
<tr>
<td>Enterprises</td>
<td>77</td>
<td>39</td>
<td>36</td>
</tr>
<tr>
<td></td>
<td></td>
<td>50.65 %</td>
<td></td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>94</strong></td>
<td><strong>53</strong></td>
<td><strong>39</strong></td>
</tr>
</tbody>
</table>

Note: When calculating the percentage, the results were rounded to the nearest integer. The number of digits to round to is 2.

10. Impact of project results

a) Impact per entity type

Table 4.24 presents the acknowledged impact of the PDIP’s both from the perspective of the end-users and from the technology vendors.

The total number of entities performing the end-user role was 42 and the technology vendor role was 38.

The impact of project results for the entities performing end-user role and technology vendor roles is summarized in Table 4.24. Impact is measured through a number of items: increasing turnover, number of clients on the internal and external market, technological level, training level, productivity and capacity to adapt to different client demands.

*Increasing turnover* and *number of clients* in both the internal and the external markets were more strongly acknowledged by technology vendors than by end-users. End-user acknowledge *increasing productivity* instead as an important item. Both end-users and technology-vendors rate quite high *increasing technological level* and *increase human resources training level*, as well as *increasing capability to adapt to client’s demands*.

Such impact on enterprise performance justifies by itself the existence of the PDIP.
Table 4.24. Impact on entities performing end-user and entities performing technology vendor role

<table>
<thead>
<tr>
<th>Impact - Item analysed</th>
<th>Impact on entity performing the end-user role</th>
<th>Impact on entity performing technology vendor role</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Number of entities</td>
<td>Percentage of entities</td>
</tr>
<tr>
<td>Increasing turnover</td>
<td>12</td>
<td>28.57 %</td>
</tr>
<tr>
<td>Increasing number of clients on internal market</td>
<td>12</td>
<td>28.57 %</td>
</tr>
<tr>
<td>Increasing number of clients on external market</td>
<td>11</td>
<td>26.19 %</td>
</tr>
<tr>
<td>Increasing technological level</td>
<td>31</td>
<td>73.81 %</td>
</tr>
<tr>
<td>Increasing human resources training level</td>
<td>30</td>
<td>71.43 %</td>
</tr>
<tr>
<td>Increasing productivity</td>
<td>27</td>
<td>64.28 %</td>
</tr>
<tr>
<td>Increasing capacity to adapt to clients' demands</td>
<td>34</td>
<td>80.95 %</td>
</tr>
</tbody>
</table>

Note:
1) The percentages were calculated from the total number of entities performing the role.
2) When calculating the percentage, the results were rounded to the nearest integer. The number of digits to round to is 2.

b) Impact on the image on the market

The vast majority (78.81 %) of the entities involved in the analysed projects acknowledged that the participation in the project had a positive impact on their image on the market. Table 4.25 shows the different entity types with impact on the market image. The entities that are usually more active in the PDIP's - enterprises and R&D institutes - are also those that better acknowledge a positive impact on their market image. More than half of the enterprises and more than one fourth of the R&D institutes claim that they obtained image improvements.

Table 4.25. Entities acknowledging positive impact on their image on the market

<table>
<thead>
<tr>
<th>Type of entity</th>
<th>Number of entities</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>University</td>
<td>9</td>
<td>7.56 %</td>
</tr>
<tr>
<td>R&amp;D Institute</td>
<td>34</td>
<td>28.57 %</td>
</tr>
<tr>
<td>Technological Centre</td>
<td>13</td>
<td>10.92 %</td>
</tr>
<tr>
<td>Enterprise</td>
<td>61</td>
<td>51.27 %</td>
</tr>
<tr>
<td>Enterprise Associations</td>
<td>2</td>
<td>1.68 %</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>119</strong></td>
<td><strong>100 %</strong></td>
</tr>
</tbody>
</table>

Note: When calculating the percentage, the results were rounded to the nearest integer. The number of digits to round to is 2.

c) Creation or reinforcement of the internal R&D activity

Table 4.26 illustrates projects' impact regarding the creation or reinforcement of the internal R&D activity, per entity type (numbers and percentages). This information was available for 146 entities.
Table 4.26. Creation or reinforcement of internal R&D activities

<table>
<thead>
<tr>
<th>Entity type</th>
<th>Number of entities</th>
<th>Creation or reinforcement of the internal R&amp;D activity</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>YES Number</td>
<td>Percentage</td>
<td>NO Number</td>
</tr>
<tr>
<td>Universities</td>
<td>14</td>
<td>5</td>
<td>35.71 %</td>
<td>8</td>
</tr>
<tr>
<td>R&amp;D Institutes</td>
<td>43</td>
<td>29</td>
<td>67.44 %</td>
<td>14</td>
</tr>
<tr>
<td>Technological Centres</td>
<td>15</td>
<td>6</td>
<td>40 %</td>
<td>8</td>
</tr>
<tr>
<td>Enterprises</td>
<td>77</td>
<td>50</td>
<td>64.93 %</td>
<td>24</td>
</tr>
<tr>
<td>Enterprise Associations</td>
<td>2</td>
<td>0</td>
<td>0 %</td>
<td>2</td>
</tr>
<tr>
<td>Total</td>
<td>151</td>
<td>90</td>
<td>-</td>
<td>56</td>
</tr>
</tbody>
</table>

Note: When calculating the percentage, the results were rounded to the nearest integer. The number of digits to round to is 2.

More than 60 % (61.64 %) of the entities recognize that the PDIP had a direct impact on the creation or reinforcement of the internal R&D activities. It is important to remark that the enterprises and the R&D institutes were the entities having the highest percentages. This is due to the fact that enterprises and R&D institutes are the main institutions absorbing most of the functions and roles (they have the required competences and they are highly motivated for the project) since they become the most involved (leading partners) in a PDIP, so they strongly feel the impact on R&D activity.

d) Institutional reinforcement of the R&D component within each partner organisation

This information was collected only from 132 entities. Table 4.27 illustrates the number and percentage of entities, per entity type, acknowledging an institutional reinforcement of the R&D component in their internal structure.

Table 4.27. Distribution of entities – per entity type – having an institutional reinforcement of the R&D component in the partner organizations

<table>
<thead>
<tr>
<th>Entity type</th>
<th>Number of entities</th>
<th>Creation or reinforcement of the internal R&amp;D activity</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>YES Number</td>
<td>Percentage</td>
<td>NO Number</td>
</tr>
<tr>
<td>Universities</td>
<td>14</td>
<td>1</td>
<td>7.14 %</td>
<td>11</td>
</tr>
<tr>
<td>R&amp;D Institutes</td>
<td>43</td>
<td>11</td>
<td>25.58 %</td>
<td>25</td>
</tr>
<tr>
<td>Technological Centres</td>
<td>15</td>
<td>1</td>
<td>6.67 %</td>
<td>11</td>
</tr>
<tr>
<td>Enterprises</td>
<td>77</td>
<td>24</td>
<td>31.17 %</td>
<td>46</td>
</tr>
<tr>
<td>Enterprise Associations</td>
<td>2</td>
<td>0</td>
<td>0 %</td>
<td>2</td>
</tr>
<tr>
<td>Total</td>
<td>151</td>
<td>37</td>
<td>-</td>
<td>95</td>
</tr>
</tbody>
</table>

Note: When calculating the percentage, the results were rounded to the nearest integer. The number of digits to round to is 2.

It is important to mention that the percentage of enterprises having an institutional reinforcement of the R&D component on their internal structure (that is gaining a place in the organigram) is quite relevant (34.29%), especially because the majority of enterprises involved in the projects analyzed are SMEs.
This is perhaps one of the most important benefits from participating in the PDIP due to the inherently structuring nature of a new unit dedicated to R&D. Almost 26% of the R&D institutes also acknowledge this type of impact; the new units usually launch new areas of work and collaborative R&D in the institutes.

e) Improved relation / cooperation with Science & Technology institutions

Tables 4.28 illustrates the number and percentage of entities, per entity type, which acknowledged that one of the outcomes of their participation in the project the creation or the improvement of the relations with the S&T institutions.

The information was available for 146 entities.

**Table 4.28. Improved relation with S&T institutions (number and percentage per entity type)**

<table>
<thead>
<tr>
<th>Entity type</th>
<th>Number of entities</th>
<th>Number and percentage of entities having improved relations with the S&amp;T institutions</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Yes</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Number</td>
</tr>
<tr>
<td>Universities</td>
<td>12</td>
<td>8</td>
</tr>
<tr>
<td>R&amp;D Institutes</td>
<td>43</td>
<td>33</td>
</tr>
<tr>
<td>Technological Centres</td>
<td>15</td>
<td>12</td>
</tr>
<tr>
<td>Enterprises</td>
<td>74</td>
<td>65</td>
</tr>
<tr>
<td>Enterprise Associations</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>146</strong></td>
<td><strong>120</strong></td>
</tr>
</tbody>
</table>

Note: When calculating the percentage, the results were rounded to the nearest integer. The number of digits to round to is 2.

Most of the entities (an average of 82.19%) have acknowledged the creation or the improvement of the relations with the S&T institutions. The highest impact (87.84%) is registered for the case of the enterprises.

11. Project management

a) Internal team

Table 4.29 illustrates the number of entities, per entity type, where an internal team was created for the development of the project. This information was available for 148 entities. 

Practically all the entities (93.99%) involved in the projects analysed created an internal team for the development of the project. Nevertheless, in around 10% of the participating enterprises this did not occur. The reasons for that were not identified by the questionnaire.
Table 4.29. Creation of an internal team for the project development

<table>
<thead>
<tr>
<th>Entity type</th>
<th>Number of entities</th>
<th>Number and percentage of entities where it was created an internal team for the development of the project</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Yes</td>
</tr>
<tr>
<td>Universities</td>
<td>13</td>
<td>12</td>
</tr>
<tr>
<td>R&amp;D Institutes</td>
<td>43</td>
<td>43</td>
</tr>
<tr>
<td>Technological Centres</td>
<td>15</td>
<td>14</td>
</tr>
<tr>
<td>Enterprises</td>
<td>75</td>
<td>68</td>
</tr>
<tr>
<td>Enterprise Associations</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>148</strong></td>
<td><strong>139</strong></td>
</tr>
</tbody>
</table>

Note: When calculating the percentage, the results were rounded to the nearest integer. The number of digits to round to is 2.

b) Project management responsibility assignment

Table 4.30 illustrates the number of entities, per entity type, where the project management responsibility was assigned to an employee. This information was available for 148 entities.

Table 4.30 Project management responsibility assignment – number and percentage, per entity type

<table>
<thead>
<tr>
<th>Entity type</th>
<th>Number of entities</th>
<th>Number and percentage of entities where the manager’s responsibility was actually assigned to a specific employee</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Yes</td>
</tr>
<tr>
<td>Universities</td>
<td>13</td>
<td>13</td>
</tr>
<tr>
<td>R&amp;D Institutes</td>
<td>43</td>
<td>42</td>
</tr>
<tr>
<td>Technological Centres</td>
<td>15</td>
<td>15</td>
</tr>
<tr>
<td>Enterprises</td>
<td>75</td>
<td>72</td>
</tr>
<tr>
<td>Enterprise Associations</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>148</strong></td>
<td><strong>144</strong></td>
</tr>
</tbody>
</table>

Note: When calculating the percentage, the results were rounded to the nearest integer. The number of digits to round to is 2.

The high tendency (97.93% of the entities involved) to assign the project management to a specific employee should be also acknowledged.

c) Direct participation of the board in the project management

This information was available for 147 entities. Table 4.31 illustrates the number and percentage of entities where the administration or board of directors was directly involved in the project management.
Table 4.31. Direct involvement of the board in the management of the project (number and percentage of entities)

<table>
<thead>
<tr>
<th>Entity type</th>
<th>Number of entities</th>
<th>Number and percentage of entities where the Board was directly involved in the management of the project</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Yes</td>
</tr>
<tr>
<td>Universities</td>
<td>13</td>
<td>1</td>
</tr>
<tr>
<td>R&amp;D Institutes</td>
<td>43</td>
<td>18</td>
</tr>
<tr>
<td>Technological Centres</td>
<td>15</td>
<td>13</td>
</tr>
<tr>
<td>Enterprises</td>
<td>74</td>
<td>57</td>
</tr>
<tr>
<td>Enterprise Associations</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>147</strong></td>
<td><strong>91</strong></td>
</tr>
</tbody>
</table>

Note: When calculating the percentage, the results were rounded to the nearest integer. The number of digits to round to is 2.

It is important to remark that the technological centres (86.67%) and the enterprises (77.03%) are the type of entities where most frequently the board of directors is directly involved in the management of the project. Universities are in the opposite situation ones from this perspective: only for 7.69% of the universities the Board was directly involved in the management of the project. This can be explained by the fact that enterprises and technological centres are the entities that usually:

- have a higher financial contribution to the project's budget, while universities and R&D institutes are in many cases subcontracted, which means that they work as providers of highly qualified resources and competences for which a middle manager (R&D unit leader, senior researcher) is qualified enough;
- are smaller in dimension and have a smaller percentage of qualified personnel, while R&D institutes and universities are very large institutions;
- give a strategic value to the project, thereby committing the most qualified staff;
- the structure each entity type has: universities have a flat structure in what concerns the R&D activities, while enterprises and technological centres have a more complex hierarchy.

12. Consortia composition and structure

a) Consortia composition

The analysis of the consortia composition shows the type of entities building the partnerships. Table 4.32 portrays consortia composition (number and percentage of projects). Other consortia composition that occurred in five of the projects were left out.
Table 4.32. Consortia composition – participating entity type (number and percentage)

<table>
<thead>
<tr>
<th>Consortia composition</th>
<th>Number of projects</th>
<th>Percentage of projects</th>
</tr>
</thead>
<tbody>
<tr>
<td>E+RDI</td>
<td>19</td>
<td>38.78%</td>
</tr>
<tr>
<td>E+U</td>
<td>8</td>
<td>16.33%</td>
</tr>
<tr>
<td>E+RDI+TC</td>
<td>7</td>
<td>14.29%</td>
</tr>
<tr>
<td>RDI+E+U</td>
<td>4</td>
<td>8.16%</td>
</tr>
<tr>
<td>RDI+TC</td>
<td>3</td>
<td>6.12%</td>
</tr>
<tr>
<td>E+TC</td>
<td>3</td>
<td>6.12%</td>
</tr>
<tr>
<td>Others</td>
<td>5</td>
<td>10.2%</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>49</strong></td>
<td><strong>100%</strong></td>
</tr>
</tbody>
</table>

Note: When calculating the percentage, the results were rounded to the nearest integer. The number of digits to round to is 2.

It is important to remark that the highest number of projects (19) where undertaken by consortia composed by enterprises and R&D institutes (38.78%). This is due to the type of the projects analysed (product development) and the fact that enterprises and R&D institutes have the main competences required by such projects.

b) Consortia structure

This analysis focuses on the main roles (researcher, technology vendor and end-user) performed within a PDIP.

Table 4.33 illustrates the different combinations of roles and the corresponding number and percentage of projects.

Table 4.33. Consortia structure – existing roles (number and percentage)

<table>
<thead>
<tr>
<th>Consortia structure</th>
<th>Number of projects</th>
<th>Percentage of projects</th>
</tr>
</thead>
<tbody>
<tr>
<td>R  TV  EU</td>
<td>18</td>
<td>36.73%</td>
</tr>
<tr>
<td>X  X  X</td>
<td>13</td>
<td>26.54%</td>
</tr>
<tr>
<td>X  X  X</td>
<td>10</td>
<td>20.41%</td>
</tr>
<tr>
<td>X  X  X</td>
<td>6</td>
<td>12.24%</td>
</tr>
<tr>
<td>X  X  X</td>
<td>1</td>
<td>2.04%</td>
</tr>
<tr>
<td>X  X  X</td>
<td>1</td>
<td>2.04%</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>49</strong></td>
<td><strong>100%</strong></td>
</tr>
</tbody>
</table>

Note:
1) R – Researcher, TV – Technology vendor, EU – End-user
2) When calculating the percentage, the results were rounded to the nearest integer. The number of digits to round to is 2.

Consortia structure including the researcher and technology vendor role had the highest percentage of occurrence among the projects analysed (36.73%), followed by consortia with the researcher, technology vendor and end-user roles (26.54%). This could again be explained by the motivation behind the projects (product development).
4.2.4. Characterization of Project Results

1. Novel products

a) Number
The total number of products obtained by the 49 projects analysed is 74, which results in an average of 1.51 products per project.

In 31 projects one product was developed, and 13 projects led to two products, two projects obtained three products and three projects determined four different products.

d) Type

Figure 4.9 presents the distribution of the novel products developed per type, classified in line with the categories considered at project objectives: final products, components or materials; systems or equipment; software applications.

![Figure 4.9. Type of novel products obtained](chart)

The level of novelty of the products obtained was acknowledged only for 72 of the novel products obtained. More than half of these novel products (56.94%) were resulting incremental innovation.

d) Introduction in the market (national, international, both)

The market in which the products were introduced was indicated in only 59 of the cases. Figure 4.10 illustrates the percentage of novel products introduced in the national or international market or in both.
e) Key/Supporting technology

Table F.1 (Annex F) illustrates the key/supporting technologies of the novel products developed. The sample was not large enough to allow us to make any in depth statistical analysis, but the knowledge of these technologies gave more insight into the projects.

It is important to underline that more than a quarter of the projects (26.53%) were based on software technology as well as that state-of-the art technologies support the analyzed PDIPs.

2. Licenses

Six projects led to technology licensing. For one of the projects it was not possible to quantify the total number of licenses obtained. A total number of 74 licenses were obtained in five projects according to the available information.

3. Associated services

Only six projects (which is 12.24 % of the total number of projects) led to the generation of services associated with the products or technologies developed.

4. Patents

a) Number

Five patents were registered by the partners of three projects. This means that 6.12% of the total number of projects produced patents.

b) Patent registration process

Only two of the project managers coordinating projects with patented results knew where the request for patenting project’s results had been done.

One of them addressed directly INPI and the other used the services of a specialized firm.
c) Reasons for not patenting the results

Figure 4.11 illustrates the reasons for not registering the patents. This information was available for 46 projects.

5. Trademarks

Five projects (which represent 10.2% from the total number of projects) generated trademarks.

6. Other results

a) Scientific results

Referring to the scientific results obtained by a project, one should distinguish publications (in conference proceedings or in scientific journals) from human resources training education (M.Sc. and PhD degrees).

In 35 projects, which represent 71.43% of the total number of projects, the research effort undertaken led to 194 publications.

Regarding human resources, 18 M.Sc. degrees were obtained as the result of the work undertaken in 12 projects and nine PhD degrees were obtained within six projects.

b) New business units

In six projects (which represent 12.24% of the total number of projects) the activities undertaken determined the creation of nine new business units.
c) Spin-offs

Three of the projects analysed led to the creation of three spin-offs, enterprises whose promoters came from the R&D institutes participating in the projects.

7) Introduction of project results in the market

Figure 4.12 shows the time period (number of years) elapsing from the end of the project until the actual introduction on the market of the project's results and their sale. It also shows the time period (number of years) elapsing between the introduction on the market and the sales of project results. This analysis refers only to the projects with marketed results.

![Bar chart showing time period for project results introduction](chart.png)

| Number of projects having a determined number of years between project's conclusion and the sale of results | 1 | 1 | 4 | 12 | 8 | 7 | 4 |
| Number of projects having a determined number of years between project's conclusion and the market introduction of the results | 1 | 1 | 4 | 15 | 6 | 7 | 3 |
| Number of projects having a determined number of years between results' introduction on the market and actual sales | 0 | 0 | 0 | 28 | 5 | 3 | 1 |

**Figure 4.12. Project results' introduction on the market**

Regarding the projects without marketed results, only one of them introduced its result on the market (one year before the project ending), but it was not sold.
A few projects were able to produce results and market them even before the formal date of conclusion. Roughly half of the projects did this within one year from the project end date and the remaining projects needed between two and three years.

8. Exploitation of results

a) Results in exploitation

36 projects have results in exploitation (which represents 73.5% of the total number of projects). Six projects (16.67%) still expect to have results in exploitation by less than one year: one of them by launching a new product and five of them through complementary developments.

More than one fourth of the projects (26.53%) did not reach results in exploitation. The reasons advocated are illustrated in Figure 4.13.

Marketed-related and commercialisation problems were behind nearly half of the reasons for not reaching exploitation of results.

Among the so-called “other reasons” for not reaching yet the exploitation of results it was possible to find: technical difficulties in following the project objectives; task un-fulfilment from one of the consortium partners; missing authorization to introduce the product on the market; absence of exploitable results.

![Figure 4.13. Reasons for not reaching exploitation of results](image)

b) Results exploited by an entity that was not a consortium member

In six of the projects (representing 12.24% of the projects analysed) the results were exploited by another partner that was not part of the initial consortium. Unfortunately it was not possible to collect more detailed information on this aspect.
c) IPR on project results

A total of 90 partners, that is 59.60% of the total number of partners involved in the 49 projects analysed, claimed having IPR’s on the project results. The IPR’s on the project results regard the exploitation within the scope of the consortia partners’ activity (this is the case for 60 partners, which represent 66.67% of the total number of partners having IPR on project results) or exploitation by third parties with payment of royalties (the case for 28 partners, which is 31.11% of all partners).

d) Entities exploiting the results

Figure 4.14 portrays the involvement of the various types of entities exploiting the project results. The analysis was based on the entity performing the Marketing & Sales function during the project execution as well as during the four forthcoming years.

Though enterprises are dominating with a share of 68%, R&D institutes and technological centres seem to play a relevant role as well.

![Figure 4.14. Entities exploiting project results](image)

4.3. Relations Established

Different criteria were used to further analyse the data collected during the survey with the objective of identifying the factors which led to project’s success in terms of the value of their results.

The main results of this analysis are presented below.
4.3.1. Criterion Used: Commercial Impact

For this analysis, the product development innovation projects were grouped according to weather or not they have generated results with an effective impact on the client markets of the participating entities.

Projects with marketed results

In this category we considered the projects that already had results marketed and sold during the project execution or that were expecting to sell results during the four forthcoming years (even if the expected quantities and/or selling income were not known).

Projects with results marketed and sold are considered the projects that have outputs (products, licenses or associated services) exchangeable in a market, thus having an economic value. From this perspective, the results marketed are the results that are recognized as a potential resource by at least somebody in the circuit of exchange.

Projects without results marketed

This category includes the projects whose results (products, licenses or associated services) were not traded in the market. The projects in this category could be further divided as follows:

- projects with results that could not be marketed;
- projects with results that were introduced in the market, but there was no entity interested in buying them;
- projects with results that could be marketed, but they were not introduced in the market; they were internally exploited by at least one of the consortium entities.

This criterion of market value of the project results was the basis for the analysis that will be presented in the following sections. The targeted sample consists of 49 projects if not specified otherwise.

1) Consortium related indicators and relations

1.1) Consortium structure

When analysing the consortia structure one was able to link the existence of major project roles (researcher, technology vendor and end-user) with the commercial impact of project results (Tables 4.34 and 4.35). The technology vendor and the researcher roles proved to be the most relevant ones for the success of a PDIP.

The developer role was not analysed more in depth because it was understood that since only product development projects were analysed, this role would be always present. However, two projects that did not have marketed results did not include the developer role, but this could also result from a misunderstanding of the respondent project coordinator side.

In order to analyse the consortium structure and its relation with the commercial impact of project results, two perspectives were considered:
- global analysis of the targeted roles (researcher, technology vendor and end-user) performed inside;
- analysis of the targeted roles (researcher, technology vendor and end-user) considering the type of entity performing a certain role.

1.1.1) Global analysis of the consortium structure, through the presence of major roles and their relation to the commercial impact of project results

Table 4.34. Relation between consortium structure – existing roles - and commercial impact of project results (number)

<table>
<thead>
<tr>
<th>Consortium structure</th>
<th>No. P</th>
<th>Number of projects with marketed results</th>
<th>Number of projects without marketed results</th>
</tr>
</thead>
<tbody>
<tr>
<td>R X TV EU X</td>
<td>1</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>X</td>
<td>6</td>
<td>2</td>
<td>4</td>
</tr>
<tr>
<td>X</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>X X X X X</td>
<td>13</td>
<td>11</td>
<td>2</td>
</tr>
<tr>
<td>X X X</td>
<td>18</td>
<td>15</td>
<td>3</td>
</tr>
<tr>
<td>X X</td>
<td>1</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>X X</td>
<td>10</td>
<td>7</td>
<td>3</td>
</tr>
<tr>
<td>Total</td>
<td>49</td>
<td>37</td>
<td>12</td>
</tr>
</tbody>
</table>

Note:
1) R: Researcher, TV: Technology Vendor, EU: End-user, No. P: Number of projects
2) When calculating the percentage, the results were rounded to the nearest integer. The number of digits to round to is 2.

Table 4.35. Relation between consortium structure – existing roles - and commercial impact of project results (percentage)

<table>
<thead>
<tr>
<th>Consortium structure</th>
<th>Percentage of projects with marketed results</th>
<th>Percentage of projects without marketed results</th>
<th>Percentage of successful projects for each consortium structure</th>
</tr>
</thead>
<tbody>
<tr>
<td>R X TV EU X</td>
<td>2,70 %</td>
<td>0 %</td>
<td>100 %</td>
</tr>
<tr>
<td>X</td>
<td>5,41 %</td>
<td>33,33 %</td>
<td>33,33 %</td>
</tr>
<tr>
<td>X</td>
<td>0 %</td>
<td>0 %</td>
<td>0 %</td>
</tr>
<tr>
<td>X X X X X</td>
<td>29,73 %</td>
<td>16,67 %</td>
<td>84,62 %</td>
</tr>
<tr>
<td>X X X</td>
<td>40,54 %</td>
<td>25 %</td>
<td>83,33 %</td>
</tr>
<tr>
<td>X X</td>
<td>2,70 %</td>
<td>0 %</td>
<td>100 %</td>
</tr>
<tr>
<td>X X</td>
<td>18,92 %</td>
<td>25 %</td>
<td>70 %</td>
</tr>
<tr>
<td>Total</td>
<td>100 %</td>
<td>100 %</td>
<td>-</td>
</tr>
</tbody>
</table>

Note:
1) R: Researcher, TV: Technology vendor, EU: End-user
2) When calculating the percentage, the results were rounded to the nearest integer. The number of digits to round to is 2.

The technology vendor and researcher roles proved to be the most relevant for the project success. If only one of these three major roles is performed, the success rate is very low. When all major roles or when the researcher and end-user role are present, a high rate of
success can also be found. The highest percentage of projects with marketed results (84.62%) is however achieved when all three roles are ensured.

The highest number (and percentage) of projects with marketed results (15 projects, respectively 40.54%) is achieved when the researcher and technology vendor roles are included. This underlines the importance of these roles and could be explained by fact that in these specific cases, where the end-user, which represents in fact the entity (or main potential entity) using the results for their commercial exploitation, is not included in the consortium, the other entities are interested in selling the results obtained.

Failing to reach the market could be explained by factors such as lack of marketing and sales abilities, the lack of adequate market studies before starting the project, project management problems or failure in the attempt to reach the targeted technological objectives.

Having a closer look to these particular projects, the main reasons for not commercialising the results of the projects provided interesting information:

• for one of the projects, the reason for not even introducing the product result in the market has been the delay in obtaining the authorization of the appropriate public authority to introduce the product in the market;
• for another project, the reasons were market changes and difficulties in commercialising the results;

However, in this particular case, the introduction in the market of the results is expected to take place in less than a year following to introducing complementary changes
• for the third project, the result was not in exploitation because it was not possible to achieve a commercial or scientific exploitation of the project results.

1.1.2) Identical analysis with restrictions to type of entities performing roles

Taking into account the results for the global analysis, by making restrictions for the type of entities: research role to be performed by a research institute, a technology center or an university; the technology vendor role to be performed by an enterprise; and the end-user role to be performed by an enterprise, the results are illustrated in the table below (Table 4.36).

<table>
<thead>
<tr>
<th>Consortium structure</th>
<th>No. P</th>
<th>Number of projects with marketed results</th>
<th>Number of projects without marketed results</th>
<th>Percentage of successful projects for each consortium structure</th>
</tr>
</thead>
<tbody>
<tr>
<td>R (RI;U;TC) TV (E) EU (E)</td>
<td>1 1</td>
<td>0</td>
<td>100 %</td>
<td></td>
</tr>
<tr>
<td>X</td>
<td>6 2</td>
<td>4</td>
<td>33.33 %</td>
<td></td>
</tr>
<tr>
<td>X</td>
<td>0 0</td>
<td>0</td>
<td>0 %</td>
<td></td>
</tr>
<tr>
<td>X X X</td>
<td>11 9</td>
<td>2</td>
<td>81.82 %</td>
<td></td>
</tr>
<tr>
<td>X X</td>
<td>15 12</td>
<td>3</td>
<td>80 %</td>
<td></td>
</tr>
<tr>
<td>X X</td>
<td>0 0</td>
<td>0</td>
<td>0 %</td>
<td></td>
</tr>
<tr>
<td>X X</td>
<td>10 7</td>
<td>3</td>
<td>70 %</td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>43</td>
<td>31</td>
<td>12</td>
<td>-</td>
</tr>
</tbody>
</table>

Note: When calculating the percentage, the results were rounded to the nearest integer. The number of digits to round to is 2.
By imposing the restrictions above, six projects had been dropped. However, the highest success rate (81.82%) is still obtained when all three roles are ensured.

1.2.) Analysis of the consortia composition, i.e. type of entities building the partnership, and their relation to project success

Table 4.37 and Figure 4.15 show the relation between consortium composition – participating entity types – and the commercial impact of project results.

The weighted average calculation for the success rate used only the values of the specific consortia composition indicated in the Table. Other consortia compositions that occurred in five of the projects were left out.

Table 4.37. Relation between consortium composition - participating entity types - and commercial impact of project results

<table>
<thead>
<tr>
<th>Consortium composition</th>
<th>No. P.</th>
<th>Number of projects with marketed results</th>
<th>Number of projects without marketed results</th>
<th>Percentage of successful projects</th>
</tr>
</thead>
<tbody>
<tr>
<td>E+RDI</td>
<td>19</td>
<td>13</td>
<td>6</td>
<td>68.42 %</td>
</tr>
<tr>
<td>E+U</td>
<td>8</td>
<td>6</td>
<td>2</td>
<td>75 %</td>
</tr>
<tr>
<td>E+RDI+TC</td>
<td>7</td>
<td>6</td>
<td>1</td>
<td>85.71 %</td>
</tr>
<tr>
<td>RDI+E+U</td>
<td>4</td>
<td>3</td>
<td>1</td>
<td>75 %</td>
</tr>
<tr>
<td>RDI+TC</td>
<td>3</td>
<td>1</td>
<td>2</td>
<td>33.33 %</td>
</tr>
<tr>
<td>E+TC</td>
<td>3</td>
<td>3</td>
<td>0</td>
<td>100 %</td>
</tr>
<tr>
<td>Others</td>
<td>5</td>
<td>5</td>
<td>0</td>
<td>-</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>49</strong></td>
<td><strong>37</strong></td>
<td><strong>12</strong></td>
<td></td>
</tr>
</tbody>
</table>

Note:
1) No. P.- Number of projects, RDI- R&D Institute, TC-Technological Centre, U-University, E-Enterprise
2) When calculating the percentage, the results were rounded to the nearest integer. The number of digits to round to is 2.

Figure 4.15. Ratio of successful projects having a determined consortium composition

Note: RDI- R&D Institute, TC-Technological Centre, U-University, E-Enterprise
The lowest success rate is found in the case of consortia built of technological centres and R&D institutes. It also comes out clearly that enterprises have a critical role in a PDIP.

When enterprises are not present in the consortia, several functions/roles that are usually covered by enterprises are simply overlooked and project failure can easily occur.

The highest success rate was found in the consortia including enterprises and technological centres, followed by the consortia with enterprises, R&D institutes and technological centres.

2) Project coordinator (leadership and management)

2.1) Relation between the education level of the project coordinator and the project success

Table 4.38 and Figure 4.16 illustrate the relation between the education level of the project coordinator, who is, in fact, the project manager of the coordinating entity and the commercial impact of project results.

For one of the projects this information was not available; the sample is thus composed of 48 projects.

It should be remarked that the seven projects run by coordinators having the highest level of training (Ph.D.) had all generated marketed results. The two projects coordinated by managers having only the basic education level had also marketed results.

The project coordinators having a PhD degree were all university professors. Two of them were project coordinators on behalf of the leading enterprises, while three others came from research institutes and four from universities.

Table 4.38. Relation between project coordinator’s education level and commercial impact of project results

<table>
<thead>
<tr>
<th>Project coordinator’s education level</th>
<th>Percentage of projects with marketed results</th>
<th>Percentage of projects without marketed results</th>
<th>Percentage of successful projects</th>
</tr>
</thead>
<tbody>
<tr>
<td>Basic education</td>
<td>8.11 %</td>
<td>0.00 %</td>
<td>100 %</td>
</tr>
<tr>
<td>Bachelor degree/ License</td>
<td>64.86 %</td>
<td>72.73 %</td>
<td>75 %</td>
</tr>
<tr>
<td>Master degree</td>
<td>8.11%</td>
<td>27.27%</td>
<td>50%</td>
</tr>
<tr>
<td>PhD</td>
<td>18.92%</td>
<td>0.00%</td>
<td>100%</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>100,00%</strong></td>
<td><strong>100,00%</strong></td>
<td>-</td>
</tr>
</tbody>
</table>

Note: When calculating the percentage, the results were rounded to the nearest integer. The number of digits to round to is 2.
Figure 4.16. Relation between project coordinator's education level and commercial impact of project results

Considering the results obtained (the highest percentage of successful projects was found in the cases when the project coordinator had as education level basic education and Ph.D. degree), a closer look was made to the position occupied by these project coordinators within the coordinating entity.

In the case of project coordinators having a Ph.D. degree, their position was: president of the board of directors, director (for two projects), project manager, area manager, researcher or shareholder.

In the case of project coordinators having basic education, their position within the coordinating entity was director (for two projects) and manager.

The education level of the project coordinator is an important factor for the success of an innovation project but no substantial conclusions could be drawn. A more in depth analysis was made considering other factors, such as the previous experience of the project coordinator in research or innovation projects.

The analysis presented by Table 4.39 adds to previous Table and Figure the correlation with the previous experience of the project coordinator in research or innovation projects. This information was not available for one of the projects, the sample consisting in 47 projects in this case.
Table 4.39. Relation between project coordinator’s education level and his/her previous experience in research or innovation project (number and percentage)

<table>
<thead>
<tr>
<th>Project coordinator’s education level</th>
<th>Previous experience in research or innovation projects</th>
<th>Without previous experience in research or innovation projects</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Number of projects with marketed results</td>
<td>Number of projects without marketed results</td>
</tr>
<tr>
<td>Basic education</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>Bachelor degree/ License</td>
<td>21</td>
<td>4</td>
</tr>
<tr>
<td>M. Sc. degree</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>Ph.D. degree</td>
<td>7</td>
<td>0</td>
</tr>
<tr>
<td>Total</td>
<td>39</td>
<td>8</td>
</tr>
</tbody>
</table>

Note: When calculating the percentage, the results were rounded to the nearest integer. The number of digits to round to is 2.

While it is still difficult to draw conclusions on the impact of the education level in the project’s success, it becomes clear that, regardless of the education level, the project coordinator’s previous experience in research or innovation projects is of paramount importance to project’s success.

2.2) Relation between the education level of the project coordinator of the entity performing the role of technology vendor and the commercial impact of project results

This analysis was made per project. If, for one of the projects, there was more than one entity performing the role of technology vendor, than the entity were the manager has the highest education level was the one selected for the analysis.

There were 33 projects that included the role of technology vendor. For one of the projects (project without marketed results) the information on the education level of the project manager of the technology vendor entity was not available and this project was not considered in the analysis. In this case, the sample consisted therefore in 48 projects.

Table 4.40. Relation between the education level of the project coordinator of the entity performing the technology vendor role and commercial impact of project results

<table>
<thead>
<tr>
<th>Project manager education level</th>
<th>Number of projects</th>
<th>Number and percentage of projects with marketed results</th>
<th>Number and percentage of projects without marketed results</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Number</td>
<td>Percentage</td>
</tr>
<tr>
<td>Basic education</td>
<td>2</td>
<td>2</td>
<td>100 %</td>
</tr>
<tr>
<td>Bachelor degree/ License</td>
<td>23</td>
<td>19</td>
<td>82.61 %</td>
</tr>
<tr>
<td>M.Sc. degree</td>
<td>2</td>
<td>2</td>
<td>100 %</td>
</tr>
<tr>
<td>Ph.D. degree</td>
<td>5</td>
<td>5</td>
<td>100 %</td>
</tr>
<tr>
<td>Total</td>
<td>32</td>
<td>28</td>
<td>87.5 %</td>
</tr>
</tbody>
</table>

Note: When calculating the percentage, the results were rounded to the nearest integer. The number of digits to round to is 2.
The table results show that the higher the education level of the project manager the higher the success rate. The differences are not significant however.

3) *Other influencing factors*

3.1) *Previous collaboration*

Figure 4.17 illustrates the relation between the existence of previous collaborations among some or all the consortium members and the commercial impact of project results. Previous collaboration among all partners of the consortium ensured the highest percentage of success, while previous collaboration among some of the partners led to better results than the total absence of previous collaboration.

![Figure 4.17. Relation between the existence of previous collaboration of the consortium members and the commercial impact of project results](image)

3.2) *Exploitation agreement*

Figure 4.18 shows the relation between the existences of an exploitation agreement duly negotiated and signed *ex-ante* (i.e. at the beginning of the project) and the commercial impact of project results. Considering these findings, it is not possible to state that the previous negotiation of an exploitation agreement represents a critical factor for the success of a PDIP, at least in this particular case.

For one of the projects (project without marketed results) this information was not available, and this case was not taken into consideration when making this analysis. The sample consists therefore of 48 projects.

This is clearly an issue to which more attention should be devoted in further work.
3.3) Previous experience in the business sector

This analysis was intended to be made considering two important roles for a PDIP: the technology vendor and the researcher roles. Unfortunately, in the case of the research role, due to an implementation misunderstanding, the information is available only for the research and development institutes.

3.3.1) For entities performing the technology vendor role

Figure 4.19 illustrates the relation between the consortium members' previous experience in the sectors where the projects are applied and their commercial impact. This analysis refers only to the entities performing the technology vendor role. Previous experience in the end-user sectors appears to be of utmost importance for the project success.

Upon the occurrence, for one of the projects, of more than one entity performing the role of technology vendor having previous experience in the industry sector(s) in which the results are applied, this was included in the analysis.

Figure 4.19. Relation between the consortium members' performing technology vendor role previous experience in the sectors where the project results are applied and their commercial impact
3.3.2) Research and development institutes

Table 4.41. Relation between R&D institutes' previous experience in the sector(s) in which the results are applied and the commercial impact of project results

<table>
<thead>
<tr>
<th>Previous experience in the sector(s) in which the results are applied</th>
<th>Number of projects with marketed results</th>
<th>Number of projects without marketed results</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Previous experience in the sector(s) in which the results are applied</td>
<td>25</td>
<td>10</td>
<td>35</td>
</tr>
<tr>
<td>Without previous experience in the sector(s) in which the results are applied</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>25</strong></td>
<td><strong>10</strong></td>
<td><strong>35</strong></td>
</tr>
</tbody>
</table>

Since all R&D institutes had previous experience in the results application sector, the present results are not very useful.

3.4) Project private funding

The analysis on the projects share of private funding was made considering two different perspectives: one to reflect the reality (distribution of percentages) and one based on statistical considerations.

When analyzing the relation between the share of private funding and the commercial impact of project results, two distinct cases were considered: a global consortium analysis for all entity types undertaking the project and a restricted analysis focusing on the enterprises as major consortium partners.

3.4.1) Funding segmentation as in the public financing programs

Global analysis

Figure 4.20 portrays the global analysis for all entities involved in the project. The sample consists of 43 projects. The share of private funding was calculated as the difference between the total budget of the project and the total amount of public funding, divided by the total budget of the project.
Figure 4.20. Relation between private funding, per project and the commercial impact of project results (funding segmentation based as in the public financing programs)

**Enterprise analysis**

A similar analysis was made for the share of private funding considering only the enterprises participating in the consortia. The budgets of the R&D institutes, universities, technological centers or other partners were therefore not considered. Figure 4.21 illustrates the relation between the share of the enterprises’ private funding and the commercial impact of project results. The indicators were calculated in a similar way as in the previous analysis. The sample used includes 43 projects.

Figure 4.21. Relation between enterprises’ private funding, per project and the commercial impact of project results (funding segmentation based as in the public financing programs)

There is a rather week link between the share of private funding and the commercial impact of the project results. If however some remark is to be left is that the lower the share of private funding the higher the projects success rate is. This can be seen as due to an higher commitment of the enterprises.
3.4.2) Funding segmentation based on statistical principles

For three of the projects information was not available on the project total budget and total funding, and for this reason they were not included in the analysis. The sample consists in this case in 43 projects.

Global analysis (including all entities involved)

Table 4.42 contains information regarding the relation between the private funding, which was calculated as the difference between the total budget of the project and the total amount financed for the respective project divided to the total budget of the project, and the commercial impact of project results.

The intervals were made taking into consideration the amplitude (variation) of the values obtained for the percentage of private funding (the minimum value obtained was 20% and the maximum value obtained was 75%), and the number of groups determined by the length of the variation intervals.

Table 4.42. Relation between private funding, per project and commercial impact of project results (number of projects)

<table>
<thead>
<tr>
<th>Percentage of private funding</th>
<th>Number of projects with marketed results</th>
<th>Number of projects without marketed results</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Between 20% and 31%</td>
<td>10</td>
<td>1</td>
<td>11</td>
</tr>
<tr>
<td>Between 31% and 42%</td>
<td>9</td>
<td>1</td>
<td>10</td>
</tr>
<tr>
<td>Between 42% and 53%</td>
<td>9</td>
<td>4</td>
<td>13</td>
</tr>
<tr>
<td>Between 53% and 64%</td>
<td>5</td>
<td>2</td>
<td>7</td>
</tr>
<tr>
<td>Between 64% and 75%</td>
<td>2</td>
<td>0</td>
<td>2</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>36</strong></td>
<td><strong>10</strong></td>
<td><strong>43</strong></td>
</tr>
</tbody>
</table>

Note: The lower limit was not included in the intervals, except the interval containing the maximum percentage.

Figure 4.22 illustrates the above-mentioned values.
Figure 4.22. Relation between private funding, per project and the commercial impact of project results

Analysis limited only to enterprises

Table 4.43 contains information regarding the relation between the private funding, which was calculated as the difference between the total budget of the enterprises, per project, and the total amount financed by the enterprises for the respective project divided to the total budget of the enterprises from the respective project, and the commercial impact of project results.

The intervals were selected taking into consideration the amplitude (variation) of the values obtained for the percentage of private funding (the minimum value obtained was 20% and the maximum value obtained was 90,51%), and the number of groups determined by the length of the variation intervals. The sample consists of 43 projects.

Table 4.43. Relation between enterprises' private funding, per project and commercial impact of project results

<table>
<thead>
<tr>
<th>Percentage of private funding</th>
<th>Number of projects with marketed results</th>
<th>Number of projects without marketed results</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Between 20% and 32%</td>
<td>8</td>
<td>1</td>
<td>9</td>
</tr>
<tr>
<td>Between 32% and 44%</td>
<td>5</td>
<td>1</td>
<td>6</td>
</tr>
<tr>
<td>Between 44% and 56%</td>
<td>10</td>
<td>3</td>
<td>13</td>
</tr>
<tr>
<td>Between 56% and 68%</td>
<td>6</td>
<td>2</td>
<td>8</td>
</tr>
<tr>
<td>Between 68% and 80%</td>
<td>3</td>
<td>1</td>
<td>4</td>
</tr>
<tr>
<td>Between 80% and 92%</td>
<td>3</td>
<td>0</td>
<td>3</td>
</tr>
<tr>
<td>Total</td>
<td>35</td>
<td>8</td>
<td>43</td>
</tr>
</tbody>
</table>

Note: The lower limit was not included in the intervals, except the interval containing the maximum percentage.
Figure 4.23. Relation between enterprises’ private funding, per project and the commercial impact of project results

The participation to the budget of the projects varies (in the case a) from 20% to 75%, and in the second case (only enterprises) from 20% to 90,51%.

That idea that successful projects have a low percentage of private funding is enforced.

4) Other relations

4.1) Relation between the level of novelty of the project results, their commercial impact and the involvement of research institutions (research and development institutes or universities) in performing the researcher role

Table 4.44 illustrates the relation between the level of novelty of project results, their commercial impact and the involvement of research institutions in performing the researcher role.

Table 4.44. R&D institutes’ and universities involvement in performing the researcher role and the novelty of project results

<table>
<thead>
<tr>
<th>Number of projects in which the researcher role was performed by an R&amp;D institute or an university</th>
<th>Number of projects with marketed results</th>
<th>Number of projects without marketed results</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Radical innovation</td>
<td>Incremental innovation</td>
<td>Radical innovation</td>
</tr>
<tr>
<td>Number of projects in which the researcher role was performed by an R&amp;D institute or an university</td>
<td>15</td>
<td>15</td>
<td>6</td>
</tr>
<tr>
<td>Number of projects in which the researcher role was not performed by an R&amp;D institute or an university</td>
<td>2</td>
<td>5</td>
<td>0</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>37</strong></td>
<td><strong>12</strong></td>
<td><strong>49</strong></td>
</tr>
</tbody>
</table>
It should to be highlighted that in 42 of the projects, which represent 85.71% from the total number of projects, the universities and research and development institutes were involved in performing the researcher role.

The obtained data shows a balance between the number of projects were radical innovation was acknowledged as having major importance and those where incremental innovation was central. No conclusions can thus be drawn regarding the effect of the entity type performing the role of researcher.

4.2) Relation between the national funding programs and commercialization of project results

Figure 4.24 shows the relation between the origin of public funding through national funding programs and the commercial impact of project results.

![Figure 4.24. Relation between funding program and the commercial impact of project results](image)

The percentages of projects with or without marketed results from the total number of projects financed by a certain program, corresponding to the above-mentioned values, are available in Table 4.45.

The number of projects financed by each program is relatively small, so any comment to the numbers encountered should be very prudent. Looking only at Praxis, Pedip and ICPME, programs for which the numbers of financed projects start to be meaningful, Pedip appeared to be the more successful and ICPME the less successful regarding the projects they have supported. The access rules of each program and the size of the enterprises are likely to be the explanation for that.
Table 4.45. Relation between funding program and the commercial impact of project results (percentage)

<table>
<thead>
<tr>
<th>National funding programs</th>
<th>Percentage of projects with marketed results</th>
<th>Percentage of projects without marketed results</th>
</tr>
</thead>
<tbody>
<tr>
<td>ICPME</td>
<td>63.63 %</td>
<td>36.37 %</td>
</tr>
<tr>
<td>IMIT</td>
<td>33.33 %</td>
<td>66.67 %</td>
</tr>
<tr>
<td>PEDIP</td>
<td>88.23 %</td>
<td>11.77 %</td>
</tr>
<tr>
<td>POE</td>
<td>100 %</td>
<td>0 %</td>
</tr>
<tr>
<td>PRAXIS I&amp;D em Consortium</td>
<td>73.33 %</td>
<td>26.67 %</td>
</tr>
<tr>
<td>PRODIBETA</td>
<td>100 %</td>
<td>0 %</td>
</tr>
</tbody>
</table>

Note: When calculating the percentage, the results were rounded to the nearest integer. The number of digits to round to is 2.

4.3) Relation between the scientific results and the commercial impact of project results

For this analysis it was considered that a project has produced a scientific result if at least one M.Sc. or a Ph.D. was achieved or at least one publication on the project results was published.

Figure 4.25 shows the relation between the projects with scientific results and the commercial impact of project results.

Figure 4.25. Relation between scientific results and commercial impact of project results

78.38 % of the projects with marketed results had generated scientific results as well and 41.67% of the projects without marketed results did not produce any scientific results.

It seems that an high quality project tends to be successful both in the commercial-market side and in the scientific side.
4.3.2. Other Performance Criteria

The following sections analyze the projects’ performance from different perspectives other than the commercial impact. The scientific output, the technological output, the level of innovativeness, and the competitiveness of project results are analyzed below, considering the various consortia composition.

Tables 4.46 and 4.47 illustrate the performance of the projects analyzed considering their market value, scientific output, technological output and innovation and competitiveness. The category “other projects” was left out, the sample consisting in only 44 projects.

**Table 4.46. Consortium composition and project commercial, technological and scientific outputs (numbers)**

<table>
<thead>
<tr>
<th>Consortium composition</th>
<th>NP</th>
<th>Market Value</th>
<th></th>
<th>Technological output</th>
<th>Scientific output</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>NP with marketed results</td>
<td>NP obtaining licenses</td>
<td>NP obtaining associated services</td>
<td>NP obtaining patents</td>
</tr>
<tr>
<td>E+RD1</td>
<td>19</td>
<td>13</td>
<td>2</td>
<td>4</td>
<td>2</td>
</tr>
<tr>
<td>E+U</td>
<td>8</td>
<td>6</td>
<td>1</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>E+RD1+TC</td>
<td>7</td>
<td>6</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>RDI+E+U</td>
<td>4</td>
<td>3</td>
<td>0</td>
<td>2</td>
<td>0</td>
</tr>
<tr>
<td>RDI+TC</td>
<td>3</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>E+TC</td>
<td>3</td>
<td>3</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Total</td>
<td>44</td>
<td>32</td>
<td>5</td>
<td>8</td>
<td>2</td>
</tr>
</tbody>
</table>

Note: NP – Number of projects

**Table 4.47. Consortium composition and project results’ innovativeness, target market and spin-offs or new business units created (numbers)**

<table>
<thead>
<tr>
<th>Consortium composition</th>
<th>NP</th>
<th>Market value</th>
<th>Innovativeness</th>
<th>Market</th>
<th>Spin-offs and new business units</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>NP with marketed results</td>
<td>RI</td>
<td>II</td>
<td>National</td>
</tr>
<tr>
<td>E+RD1</td>
<td>19</td>
<td>13</td>
<td>7</td>
<td>8</td>
<td>5</td>
</tr>
<tr>
<td>E+U</td>
<td>8</td>
<td>6</td>
<td>2</td>
<td>4</td>
<td>2</td>
</tr>
<tr>
<td>E+RD1+TC</td>
<td>7</td>
<td>6</td>
<td>3</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>RDI+E+U</td>
<td>4</td>
<td>3</td>
<td>2</td>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td>RDI+TC</td>
<td>3</td>
<td>1</td>
<td>0</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>E+TC</td>
<td>3</td>
<td>3</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Total</td>
<td>44</td>
<td>32</td>
<td>15</td>
<td>19</td>
<td>14</td>
</tr>
</tbody>
</table>

Note:
1) NP – Number of projects; RI – Radical Innovation; II – Incremental Innovation
2) There were cases when one project had more than one product and the products had different levels of novelty and they were introduced on different markets.

Tables 4.48 and 4.49 portray the percentage corresponding to the successful projects considering the above-mentioned categories. The percentages were calculated from the total number of projects with marketed results.
### Table 4.48. Consortium composition and project commercial, technological and scientific outputs (percentage)

<table>
<thead>
<tr>
<th>Consortium composition</th>
<th>Commercial impact</th>
<th>Technological output</th>
<th>Scientific output</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>PP</td>
<td>PP</td>
<td>PP</td>
</tr>
<tr>
<td></td>
<td>obtaining licenses</td>
<td>obtaining associated services</td>
<td>obtaining patents</td>
</tr>
<tr>
<td>E+RDI</td>
<td>68.42%</td>
<td>15.38%</td>
<td>30.77%</td>
</tr>
<tr>
<td>E+U</td>
<td>75%</td>
<td>16.67%</td>
<td>33.33%</td>
</tr>
<tr>
<td>E+RDI+TC</td>
<td>85.71%</td>
<td>0%</td>
<td>0%</td>
</tr>
<tr>
<td>RDI+E+U</td>
<td>75%</td>
<td>33.33%</td>
<td>66.67%</td>
</tr>
<tr>
<td>RDI+TC</td>
<td>33.33%</td>
<td>100%</td>
<td>0%</td>
</tr>
<tr>
<td>E+TC</td>
<td>100%</td>
<td>0%</td>
<td>0%</td>
</tr>
</tbody>
</table>

Note:
1) PP – Percentage of projects
2) When calculating the percentage, the results were rounded to the nearest integer. The number of digits to round to is 2.

### Table 4.49. Consortium composition project results’ innovativeness, target market and spin-offs or new business units created (percentage)

<table>
<thead>
<tr>
<th>Consortium composition</th>
<th>Innovativeness</th>
<th>Market</th>
<th>Spin-offs and new business units</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>RI</td>
<td>II</td>
<td>National</td>
</tr>
<tr>
<td>E+RDI</td>
<td>53.85%</td>
<td>61.54%</td>
<td>38.46%</td>
</tr>
<tr>
<td>E+U</td>
<td>33.33%</td>
<td>66.67%</td>
<td>33.33%</td>
</tr>
<tr>
<td>E+RDI+TC</td>
<td>50%</td>
<td>50%</td>
<td>66.67%</td>
</tr>
<tr>
<td>RDI+E+U</td>
<td>66.67%</td>
<td>66.67%</td>
<td>33.33%</td>
</tr>
<tr>
<td>RDI+TC</td>
<td>0%</td>
<td>100%</td>
<td>100%</td>
</tr>
<tr>
<td>E+TC</td>
<td>33.33%</td>
<td>33.33%</td>
<td>33.33%</td>
</tr>
</tbody>
</table>

Note:
1) NP – Number of projects; PP – Percentage of projects; RI-Radical Innovation; II – Incremental innovation
2) There were cases when one project had more than one product and the products had different levels of novelty and they were introduced on different markets.
3) When calculating the percentage, the results were rounded to the nearest integer. The number of digits to round to is 2.

The results proved that the consortia composed by enterprise and technological centres provided not only the highest success rate in terms of commercial impact, of project results, but also a considerably high scientific output. All consortia composed of enterprises, R&D institutes and technological centres that had marketed results produced scientific output. Consortia composed of enterprise and university, and enterprise and R&D institutes attained not only relatively high success in terms of commercial impact of project results, but also generated significant technological and scientific output and generated new business units.

The highest level of innovativeness (radical innovation) is achieved when the consortium includes both a R&D institute and an university.
Chapter 5. Proposed Framework

PDIPs can be regarded temporary structures or organizations which may be modelled as systems, as illustrated in Figure 5.1.

![Diagram of PDIP as System](image)

Figure 5.1. PDIP as system

PDIPs require inputs of different types in order to be able to generate the targeted outputs. As a system, a PDIP may be looked at as a complex aggregate of different elements.
The different elements of a PDIP are now briefly presented according to the structure proposed in Figure 5.1.

1. Inputs

A number of elements defining the goal-oriented consortium build a project temporary collaborative networked organisation which is set up with the objective of developing a certain number of tasks and activities, defined in a specification document called a Technical Annex, in order to reach a set of goals and results by following the strategy developed.

Such temporary network is a consortium composed of different actors (Universities, R&D Institutes, Technological Centres, Enterprises and Enterprise Associations) that perform different roles (researcher, developer, end-user, technology vendor, coordinator or funding partner) and/or functions (coordination, funding, basic research, applied research, development, marketing & sales, maintenance & support, dissemination, consultancy, training, IPR protection, demonstration, test & validation).

Several types of resources have to be provided in order to achieve the targeted outputs: (existing and developed) knowledge and technology; human resources; capital and assets; market research.

All the above-mentioned elements can be generically called project inputs.

2. Outputs

The outputs of a PDIP are the tangible and/or intangible results to be attained. They may be of rather different nature: novel products, licences, associated services, trademarks, patents, new business units created, spin-offs, scientific results, improved business processes, improved competitiveness, etc. These results have actual and/or potential market value.

3. Environment

All PDIP elements are influenced by the environment in which they are performed. The environment includes and defines the national social, economical and political conditions and restrictions (that facilitate the climate to innovation, but sometimes create barriers) in which the projects are undertaken, as well as the particularities of each institution involved, such as corporate culture, etc.

4. The PDIP

The PDIP performance results from the actual combination of the different activities culminating with the creation of novel products and/or technologies. It includes PDIP design and planning, project’s execution, results marketing & commercialisation and products’ support activities.

The research study undertaken allowed us to complement this model/description of a PDIP with a proposal of a modelling framework (Figure 5.2) aimed to provide a better understanding and a deeper insight for PDIPs organization and management.
Figure 5.2. Proposed modelling framework for product development innovation projects
1. Goal
The overall aim of the modelling framework is to provide a deeper insight in PDIP organization and management by describing the internal structure and links of a PDIP undertaken by an association of different entities, a consortium. It represents a pictorial description of the reality enabling a better and deeper understanding, and, hopefully, from this improved understanding usefulness for the project management would emerge.

It is important to mention that this modelling framework supports a broad understanding of key critical factors for successful PDIPs (in terms of marketed results, but not only) undertaken by consortia. Several particular aspects of the institutions involved in such consortia (i.e. entity’s learning capacity, project results implementation, decision making at entity level, etc.) are not considered since they would be out of the scope of the present work.

The modelling framework could be useful during all PDIP phases: during early planning phase it could be used to identify the type of partners, functions, roles, resources required in order to undertake the PDIP and to make the initial project audit by the funding institutions; throughout the project execution, results marketing & commercialisation and during product support activities phases in order to identify the missing parts. It could be also used after the project officially ends in order to support the final evaluation of the project, by the funding institutions, and/or by the project coordinator(s) in order to have a global view from the management perspective.

Better selection criteria at an early ex-ante analysis stage when funding is requested can be derived. And objective measures for the project success ex-post evaluation can also be delivered, putting the project consortium accountability in the agenda.

2. Context
Contingency theory could be relevant for PDIPs. The key and support technology used, the products aimed to be attained, consortium structure and composition, particular internal and external environment, etc. depend on the context.

This is however the uncontrollable element to which the others must adapt in real-time.

3. Framework description
The inputs (strategy, goals, resources, actors, functions, roles, etc.) are the enablers of the whole process of developing PDIPs.

Project performance is sought in four different phases:
• Project preparation (design and planning). During this phase the project goals are set, the strategy is built, the functions, roles and competences are determined, thereby being defined, the consortium structure and composition, as well as the partners allocation to the different functions and roles.
• Project execution. The inputs are transformed into outputs by undertaking the different tasks and activities previously specified in the Technical Annex.
• Results marketing & commercialisation. The project officially ends when the results (final products, machines, equipment, systems, software applications, etc.) are obtained usually in a preliminary prototype stage. At this stage, the project results will hopefully show an actual and/or potential market value.
• Product support activities. Several activities are required in order to support project results after being placed in the market and sold: maintenance, upgrading, recycling, etc.
The last two phases often start during project execution.

Project's coordination and leadership provide the operational support to the project's strategy and goals, they accompany all PDIP phases - starting with the project preparation phase and they continue throughout the PDIP lifetime. They are both critical drivers ensuring PDIPs success.

Market focus and technology and knowledge perspective require several flows during all PDIP's phases. They are both push-pull mechanisms and they provide continuous bidirectional flows. The existing technology and knowledge are used, and new technology and knowledge are produced and put on the market. The focus on the market requirements should be especially strong during the design and planning phase, but it should be kept throughout the PDIP lifetime.

Several elements should be considered during each of PDIP's phases which determine the ultimate project success, therefore being considered as critical factors:

During the project design and planning phase: strategy and goals definition; resource allocation; functions and roles allocation; consortium structure; consortium composition; management rules.

During project actual execution phase: functions and roles fulfilment; partners' performance; spin-off development; management performance.

During results marketing & commercialisation and product support activities: results' marketing strategy; business agreements; functions and roles fulfilment; product support responsibilities; generation of future innovation projects.
Chapter 6. Conclusions and Recommendations

6.1 Introduction

The aim of this section is to summarize the most relevant findings of the present work and to present a set of recommendations for further work. The conclusions of the work undertaken are presented, followed by the identification of its contribution to the area of innovation. A set of recommendations is then presented which includes, among others, the limitations of the work. The recommendations put forward can be used by policy makers, project managers, funding organizations, as well as by the entities that intend to undertake a project in consortium. Finally, a brief insight is done in the work to be developed in the future as possible follow-up of the present thesis.

6.2. Conclusions of the Work

It would be naïve to think that all the issues mentioned in the title of the present thesis could be completely solved on the basis of just few months of research. Nevertheless, the results obtained and the subsequent analysis allowed us to draw some conclusions and elaborate a few recommendations with potential of application in many practical situations by funding organizations, policy makers, project managers or entities planning to be involved (or already being involved) in collaborative R&D projects. The work also provides a novel comprehensive view on of PDIPs undertaken by enterprise-university consortia.

The broadly accepted sequential innovation model no longer provides a satisfactory interpretation of the present rapid economic changes. Business activities grow more complex, and the Linear Model of innovation is not able to capture the real flows of value-added, losing its explaining power on the real economy. However, it represents the reference for the later more complex innovation models and was used as the basis for the current study.

Innovation is a very complex process. It is not only about creating novel products (and/or services) that solve current problems. They should fulfil market needs and create economic value. As Lynn White said (White, 1996) “New technology opens a door…. it does not command one to enter”. The commercial impact of project results determines, in fact, sustainable development within economy. This is why the analysis work undertaken has been guided by one major purpose: to identify and explain the factors leading to PDIP success in terms of marketed/ sold project results.

Innovation requires a wide range of competences, such as appropriate coordination, commitment or allocation of sufficient financial resources, etc. It is a complex process and its management and outputs are strongly dependent on the complex interaction among the different actors involved.

It is very difficult for a single entity, if not totally impossible in the case of SME’s, to perform all the roles and functions required by a PDIP. Strategic alliances emerge therefore as a valuable alternative to have access to external resources and competences.
The fact that some consortia do a better job than others in successfully running a PDIP is not an accident. Several factors, some of which are often neglected if they are ever identified, play a relevant role. Successful innovation does not depend on a uniform process or on a planned approach; it is inherently dynamic and evolutionary.

The results obtained allowed us to identify several factors influencing PDIP's success (mostly in terms of the commercial impact of the project results) that are briefly presented below. Some of the relations established indicated elements strongly influencing PDIP's success, that we may call key drivers or critical success factors.

These results can be used by the funding institutions when initially evaluating project proposals and when making the final audit of the PDIPs. They can be useful also for the consortium members (mainly for the project coordinator) to identify the gaps throughout PDIPs development and also when the project ends by providing a global view from the management perspective.

Based on the quantitative data, the following drivers were identified as influencing PDIP's success (especially in terms of commercial impact):

- **Consortium composition – consortia formed by enterprises, R&D institutes and technological centres**

  Consortia undertaking a PDIP composed of enterprises, R&D institutes and technological centres determined the highest percentage of successful projects (85.71%). Considering their technical competences and main activities, they are to cover the main roles and functions required to a successful PDIP. This consortium composition registered also a very high successful scientific output (in 85.71% of the cases).

  Very high percentages were obtained also for consortia formed by enterprises and universities or enterprises, universities and R&D institutes (75% in both cases) and those formed by enterprises and R&D institutes (68.42%).

- **Consortium structure – consortia performing researcher, technology vendor and end-user roles**

  By analysing consortium structure, one was able to conclude that the consortia performing the researcher, technology vendor and end-user roles, among others, have achieved the highest success rate (in 84.62% of the projects they have generated marketed results). The analysis made only for enterprises performing these roles indicated the same consortium structure as the most successful (in 81.82% of the projects).

  The consortia including only the first of the two above-mentioned roles (researcher and technology vendor roles) determined also a high rate of success (in 83.33% of the projects).

- **Project coordinator's previous experience in research or innovation projects**

  In 32 of the projects (82.05%) where the project manager of the coordinating entity had previous experience in research or innovation projects, the project results had acknowledged commercial impact.
• Previous collaboration among all consortium partners

When analysing the relation between the existence of previous collaboration within the consortia and the commercial impact of project results, the highest percentage of successful projects (95.65%) was registered when all consortium partners have had previous collaboration.

The alliances built support long-term relationships and permanent collaboration among consortia members, lasting more than a single project duration and ensuring sustainable innovation strategies.

• Previous experience in the business sector of the entity performing the technology vendor role

A very high success rate (86.67%) was found for the projects where at least one of the entities performing the technology vendor role within the consortium had previous experience in the business sectors in which the results were to be applied.

Other results obtained from the data collected (mainly qualitative data) and other information gathered from the face-to-face interviews with the project coordinators allowed us to identify other drivers relevant for PDIPs, but no numerical analysis can support these results.

• Coordination function

The coordinating entity assumes a critical role in a PDIP especially due to the complexity of the innovation process and its management, the diversity of the actors involved and their different interests, ways of work and cultures.

The coordination function should be performed not only during project execution, but should be assumed and performed even during project design and planning and pursued after the project officially ends.

PDIPs undertaken by consortia require a common effort necessary to achieve synergies while following the project’s goals.

• Market research and focus

The focus on the market should accompany PDIPs performance: in order to identify market needs, and to investigate the existing technology and knowledge that could be incorporated in the development of the novel product aimed to be attained. Also, after the project officially ends relatively small improvements could be sought that could be embedded into the initial novel product attained, with very little costs, but which could determine significant turnover.

A PDIP can obtain a remarkable novel product (that could be even a world first), but if it does not exists a buyer for it the project is a failure in terms of commercial impact.

• Technology and knowledge focus

The consortium members should dominate the existing technologies and knowledge since the project results are a push on the market. Also elements of the existing technology and knowledge could be used while developing the novel products.
• Allocation of roles and functions among consortia members and fulfilment of the functions/roles assigned

The allocation of functions and roles among consortia members (entity types) is an important factor with a significant effect on the commercial impact of project results. There should be considered facts such as: previous experience (i.e.: in research or innovation projects, in the end-user business sectors, in performing the required roles or functions) and competences. Technology vendor, researcher and end-user were found roles of utmost importance.

• Enterprises play an important role

The enterprises play a unique role. By embracing people, capital and innovation while following their goals (to increase market share and ensure revenue for the stakeholders) they contribute to the development of research activities. Coordination, funding, development, marketing & sales, maintenance & support, demonstration and test & validation functions were indicated as the most adequate functions for enterprises. Besides those, among the main roles performed are the ones of coordinator, developer and technology vendor.

• Adequacy in performing a function

Regarding the adequacy of an institution to perform a certain function, the enterprises were indicated as the most adequate institutions to perform tasks such as coordination, funding, development, marketing & sales, maintenance & support, demonstration and test & validation.
The R&D institutes were appointed as the most adequate entities to perform tasks like basic research, applied research, consultancy, training and IPR Protection.

It is important to mention that, besides the commercial impact of project results, other aspects could be analysed, such as: technological output, scientific output, spin-offs or new business units created, etc.

Based on the data collected and the results obtained, a very simple SWOT analysis for PDIPs undertaken by consortia was also made.

The strengths identified are:
• Access to the necessary competences and resources
• Shared risk
• Synergies created by partner interaction
• Establishment of strategic alliances for business

The weaknesses identified are:
• Lack of market focus
• Lack of staff with the adequate skills and availability from the company side
• The common difficulty to define platforms of collaboration among different types of partners

The opportunities identified are:
• Improved collaboration between public and private sectors
• Improved access to financial resources
The threats identified are:
• Conflicting interests between the public policy and the private sector
• Different interests among consortia members
• "Sleeping" partners unfulfilling their roles or functions
• Overlapping of functions and/or roles
• Lack of coordination
• Project manager’s lack of experience in innovation or research projects
• Unbalanced power relations
• Lack of communication and support among consortia partners
• Competition among consortia partners
• Informal coalition formation

The results obtained underline the need to develop and maintain cooperation networks gathering together universities, R&D institutes, technological centres, enterprises and enterprise associations in order to ensure the competences required for a successful PDIP.

It is important to emphasize that the results obtained are very significant for small and medium sized enterprises, which represented the majority of the entities involved in this study and which are dominant in the Portuguese economic tissue. Moreover, the existence of networks is of paramount importance, giving SMEs access to strategic competences that they do not have: technology, funding, and even project management.

The objectives set for the analysis were achieved. The questions regarding the aim of this thesis were answered and a modelling framework was proposed - even if this was not an objective initially set. The results obtained support a better understanding and characterization of the innovation process in collaborative R&D projects in Portugal, based on the findings of the research study on 49 product development innovation projects undertaken by university-enterprise consortia.

6.3. Novel Contributions

Nowadays, the concept of innovation tends to focus strongly on the technological innovation aspects and the results of an innovation project are focusing primarily on new technology acquisition and technology development. The present work provides an in depth look, at micro level, to the process through which novel products are attained.

The work undertaken led to a number of contributions, respectively:

• The work undertaken provides a quantifiable characterization of university-enterprise collaborative R&D projects in Portugal.

• The results obtain highlight on the positive impact of public policies for supporting product innovation in Portugal.

• The success factors of collaborative R&D projects were identified and analyzed using both qualitative and quantitative criteria.
• A simple model describing the different elements of a product development innovation project as well as the various links and interactions among them was drafted.

6.4. Recommendations for Future Work

On the field survey work

Undertaking this research project allowed the elaboration of a set of recommendations.

• If the survey field work is to be undertaken by a team, very good communication within team-members should be assured. The tasks should be very well defined and training should be provided in order to assure an equal level of preparation for all team-members involved.
• It would be highly recommended that the person processing the data participates in some or even all interviews. In this way small inconsistencies generated by the lack of uniformity can be avoided.
• The questionnaire should be well tested and the necessary time should be allocated in order to structure it in a clear and comprehensive way.

The study undertaken has several limitations, among which one should mention two very important aspects:
• The analysis is based on the Linear Model of innovation. Research is considered as the source of innovation and the flows/interactions among different PDIP phases and actors are not analysed.
• The “intangible” outputs of the innovation (i.e. knowledge, know-how) are not adequately considered.

Several other limitations were generated by misunderstandings within team-members, especially questionnaire implementation misunderstandings. For example, question x0106 should have been addressed only to enterprises, enterprise associations and technological centres. It is understood that R&D institutes and universities already have an R&D component

Other limitations of the study are generated by the lack of information collected. For example, it was sought to compare, in the case of projects with marketed results, the turnover obtained and the investment made. Unfortunately, due to reasons such as the lack of information concerning the turnover obtained; the difficulty to quantify all the investment made, per partner (not only in financial terms); the difficulty to quantify the turnover (as PDIPs, some projects could obtain turnover even in more than five years) it was not possible to undertake this analysis. Besides, the positive impact could be positive in terms of competitiveness.

The limitations of this type of survey are well known and could have various causes, but interpreted with proper care, they can provide useful and most valuable information.

Further work should take into account these restrictions as to try to eliminate them or to control their effects.
On the PEDIP’s

The study allowed us to draw several conclusions on the PDIPs undertaken by consortia, but there are still many open questions that can be the starting point for further research work, such as:

- How should be the PDIPs management optimised?
- How can the PDIP’s help building the link between innovation project and enterprise strategy?

Other suggestions for further analysis may refer to:

- A more in depth analysis made from the perspective and considering the requirements of the national funding programs that put in place the government technological policies
- Functions’ analysis considering entity types’ involvement and their adequacy to perform a certain function
- Undertaking “case-studies” & best-practices analysis from selected successful PDIPs in the sample of this survey or other projects
- Improvement of the questionnaire & survey methodology building on the past experience
- Comparing (where possible) the results obtained with the results from other studies undertaken in Portugal.
References


18. CORDIS, European Innovation Scoreboard: www.eu.int/comm/enterprise/library or www.trendcharts.cordis.lu

19. CORDIS, European Innovation Scoreboard No. 14/2004


21. CPROST Center for Policy Research on Science and Technology www.sfu.ca/cprost


34. Myers, M., Rosenbloom R., - Rethinking the Role of Industrial Research, Engines of Innovation, Rosenbloom, R. S., and Spencer, W. J. (Eds.), Harvard Business Scholl Press, pp.209-228, 1998


Web pages

1. ADI – Innovation Agency  www.adi.pt
2. FCT – The Foundation of Science and Technology www.fct.mces.pt
3. IMIT Programme – www.iapmei.pt
4. OCES of MCES: www.oces.mces.pt
5. Statistics Canada: www.statcan.ca
6. STRINOP Project www.strinnop.net
Bibliography


Annex A. Survey Questionnaire

Annex A.1. Questionnaire

Presentation
The Institute of Systems and Computers Engineering of Porto (INESC Porto - Instituto de Engenharia de Sistemas e Computadores) is undertaking, by contract with the Observatory of Science and Higher Education (OCES - Observatório da Ciência e do Ensino Superior) of the Ministry of Science and Higher Education (MCES - Ministério da Ciência e do Ensino Superior), a research study on product development innovation projects undertaken by consortia funded by national and EU programs.

In this context, INESC Porto is undertaking an inquiry to the Portuguese entities (Universities, R&D Institutes, Technological Centres, Enterprises, Enterprise Associations or Funding Institutions) that participated in product development innovation projects co-financed by national or EU programs.

Your institution took part in these type of projects. We are kindly asking you, in this way, for your good collaboration by answering the questions that are addressed to you by this questionnaire.

We take advantage of this to remind you that this study is aimed to a better understanding of the importance of product development innovation projects for Portuguese enterprises, with a view on a better adequacy of future programs to needs of the industry.

Objective
The objective of this study is to evaluate and characterise the innovation process for product development innovation projects supported by national and European programs.

Confidentiality
All the information supplied is protected by ensuring the confidentiality. INESC Porto will not make public none of the information obtained from this inquiry that could make possible the identification of the institution, without your agreement.

Inquiry
The electronic questionnaire should be opened together with the Macros. All the files have been tested, guarantying the absence of the viruses.

The questionnaire contains the following parts:
1) Project for a brief description and characterization of the project developed
2) Coordinator for the entities being project coordinator
3) Partners for the remaining partners' characterization
4) Results for the characterization of the main results of the project developed

Support and clarifications
Any doubt in filling up the questionnaire or in sending it can be clarified by phone 222 093 000 or fax 222 094 350, INESC Porto, to the attention of Eng. Paula Silva

Acknowledgements
INESC Porto, on its behalf and on behalf of OCES of MCES, are thanking you for your collaboration in answering to this questionnaire.

In order to proceed with the questionnaire, please load the links below:
Introduction
Project
Partners
Results
<table>
<thead>
<tr>
<th>Reference</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Acronym</td>
<td></td>
</tr>
<tr>
<td>Number of partners</td>
<td></td>
</tr>
<tr>
<td>Interviewer</td>
<td></td>
</tr>
<tr>
<td>Date of interview</td>
<td></td>
</tr>
<tr>
<td>Place of interview</td>
<td></td>
</tr>
<tr>
<td>Respondent</td>
<td></td>
</tr>
<tr>
<td>Telephone</td>
<td></td>
</tr>
<tr>
<td>E-mail</td>
<td></td>
</tr>
<tr>
<td>Notes</td>
<td></td>
</tr>
<tr>
<td>Status</td>
<td></td>
</tr>
<tr>
<td>Verified</td>
<td></td>
</tr>
<tr>
<td>Questionnaire, OCES</td>
<td>Project</td>
</tr>
<tr>
<td>-------------------</td>
<td>---------</td>
</tr>
<tr>
<td><strong>Project Characterization</strong></td>
<td></td>
</tr>
<tr>
<td>101 Code</td>
<td></td>
</tr>
<tr>
<td>102 Acronym</td>
<td>0</td>
</tr>
<tr>
<td>103 Name</td>
<td></td>
</tr>
<tr>
<td>104 Type</td>
<td>Product development</td>
</tr>
<tr>
<td>105 Objective</td>
<td></td>
</tr>
<tr>
<td>106 Total budget</td>
<td>0 €</td>
</tr>
<tr>
<td>107 Total funding</td>
<td>0 €</td>
</tr>
<tr>
<td>108 Number of partners</td>
<td>0</td>
</tr>
<tr>
<td>109 Funding programs</td>
<td>N/A</td>
</tr>
<tr>
<td>111 If different, which one?</td>
<td></td>
</tr>
<tr>
<td>112 Planned starting date</td>
<td></td>
</tr>
<tr>
<td>113 Planned ending date</td>
<td></td>
</tr>
<tr>
<td>114 Actual starting date</td>
<td></td>
</tr>
<tr>
<td>115 Actual ending date</td>
<td></td>
</tr>
<tr>
<td>116 Keywords</td>
<td></td>
</tr>
<tr>
<td>117 INTERNET Web-page</td>
<td></td>
</tr>
<tr>
<td>118 Had the partners already collaborate in previous projects?</td>
<td></td>
</tr>
<tr>
<td>119 How many entities were involved in the creation of the project?</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>INESC Porto</th>
<th>OCES</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>Questionnaire, OCES</th>
<th>Project</th>
</tr>
</thead>
<tbody>
<tr>
<td>120 Was it made any consortium agreement for the exploitation of the intellectual property rights of project’s results?</td>
<td></td>
</tr>
<tr>
<td>121 In which way did the project start?</td>
<td>☐ Natural (Direct) consequence of another project ☐ Project created from roots</td>
</tr>
<tr>
<td>123 Did the project give birth to another new project?</td>
<td></td>
</tr>
<tr>
<td>124 Did the consortium use any dissemination/technology transfer network for disseminating project results?</td>
<td></td>
</tr>
<tr>
<td>125 If yes, which one? (If yes, please specify)</td>
<td></td>
</tr>
</tbody>
</table>
### General Information on the Coordinating Entity

<table>
<thead>
<tr>
<th>Question</th>
<th>Answer</th>
</tr>
</thead>
<tbody>
<tr>
<td>Entity's name</td>
<td></td>
</tr>
<tr>
<td>Address</td>
<td></td>
</tr>
<tr>
<td>District</td>
<td></td>
</tr>
<tr>
<td>NUT Region</td>
<td></td>
</tr>
<tr>
<td>Entity type</td>
<td></td>
</tr>
<tr>
<td>Partner's legal creation date</td>
<td></td>
</tr>
<tr>
<td>Person responsible in the project's coordination</td>
<td></td>
</tr>
<tr>
<td>Telephone</td>
<td></td>
</tr>
<tr>
<td>E-mail address</td>
<td></td>
</tr>
<tr>
<td>Position</td>
<td></td>
</tr>
<tr>
<td>Education level</td>
<td></td>
</tr>
<tr>
<td>Did the project coordinator had previous experience in research or innovation projects?</td>
<td>Yes</td>
</tr>
<tr>
<td>Role performed by the entity</td>
<td></td>
</tr>
<tr>
<td>If different, please specify</td>
<td></td>
</tr>
<tr>
<td>CAE Activity sector</td>
<td></td>
</tr>
<tr>
<td>SIC Activity sector</td>
<td></td>
</tr>
<tr>
<td>Brief description of the main activity developed</td>
<td></td>
</tr>
</tbody>
</table>

---

### INESC Porto

<table>
<thead>
<tr>
<th>Question</th>
<th>Answer</th>
</tr>
</thead>
<tbody>
<tr>
<td>Entity's name</td>
<td></td>
</tr>
<tr>
<td>Turnover</td>
<td>2003</td>
</tr>
<tr>
<td>Exports</td>
<td>2003</td>
</tr>
<tr>
<td>Which is the number of employees, per education level:</td>
<td>0</td>
</tr>
<tr>
<td>Primary School</td>
<td></td>
</tr>
<tr>
<td>Secondary School</td>
<td></td>
</tr>
<tr>
<td>License / Bachelor degree</td>
<td></td>
</tr>
<tr>
<td>M.Sc. degree</td>
<td></td>
</tr>
<tr>
<td>PhD</td>
<td></td>
</tr>
<tr>
<td>Partner's budget for the project</td>
<td></td>
</tr>
<tr>
<td>Partner's funding for the project</td>
<td></td>
</tr>
<tr>
<td>Which was the partner's role in the creation of the project?</td>
<td></td>
</tr>
<tr>
<td>Was it an internal team created to undertake the development of the project?</td>
<td>Yes</td>
</tr>
<tr>
<td>Was the responsibility of the project formally assigned to a collaborator of the entity?</td>
<td>Yes</td>
</tr>
<tr>
<td>Which was the coordinator's percentage of involvement in the project?</td>
<td></td>
</tr>
<tr>
<td>Did the Board of Directors have a direct participation in project's management?</td>
<td>Yes</td>
</tr>
<tr>
<td>Did the partner already have participated in innovation projects?</td>
<td></td>
</tr>
<tr>
<td>Did the partner already have a R&amp;D department? If yes, please indicate the number of persons in that department.</td>
<td>Yes</td>
</tr>
</tbody>
</table>

---

### OCES

<table>
<thead>
<tr>
<th>Question</th>
<th>Answer</th>
</tr>
</thead>
<tbody>
<tr>
<td>Entity's name</td>
<td></td>
</tr>
<tr>
<td>Turnover</td>
<td>2003</td>
</tr>
<tr>
<td>Exports</td>
<td>2003</td>
</tr>
<tr>
<td>Which is the number of employees, per education level:</td>
<td>0</td>
</tr>
<tr>
<td>Primary School</td>
<td></td>
</tr>
<tr>
<td>Secondary School</td>
<td></td>
</tr>
<tr>
<td>License / Bachelor degree</td>
<td></td>
</tr>
<tr>
<td>M.Sc. degree</td>
<td></td>
</tr>
<tr>
<td>PhD</td>
<td></td>
</tr>
<tr>
<td>Partner's budget for the project</td>
<td></td>
</tr>
<tr>
<td>Partner's funding for the project</td>
<td></td>
</tr>
<tr>
<td>Which was the partner's role in the creation of the project?</td>
<td></td>
</tr>
<tr>
<td>Was it an internal team created to undertake the development of the project?</td>
<td>Yes</td>
</tr>
<tr>
<td>Was the responsibility of the project formally assigned to a collaborator of the entity?</td>
<td>Yes</td>
</tr>
<tr>
<td>Which was the coordinator's percentage of involvement in the project?</td>
<td></td>
</tr>
<tr>
<td>Did the Board of Directors have a direct participation in project's management?</td>
<td>Yes</td>
</tr>
<tr>
<td>Did the partner already have participated in innovation projects?</td>
<td></td>
</tr>
<tr>
<td>Did the partner already have a R&amp;D department? If yes, please indicate the number of persons in that department.</td>
<td>Yes</td>
</tr>
<tr>
<td>Questionnaire, OCES</td>
<td>Coordinator</td>
</tr>
<tr>
<td>---------------------</td>
<td>-------------</td>
</tr>
<tr>
<td><strong>Project's impact on the partner</strong></td>
<td></td>
</tr>
<tr>
<td>Which was the impact of project's results for the partner performing the end-user role?</td>
<td>FALSE</td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td>Did the partner performing technology vendor role already have experience in the end-user activity sectors?</td>
<td>FALSE</td>
</tr>
<tr>
<td>Which was the impact of the project's results for the partner performing the technology vendor role?</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td>Did the R&amp;D partner already have experience in the end-user activity sectors?</td>
<td></td>
</tr>
<tr>
<td>Was the cooperation relation with the Science &amp; Technology institutions created or reinforced?</td>
<td></td>
</tr>
<tr>
<td>Did the partner participate in similar projects after the project ended?</td>
<td></td>
</tr>
<tr>
<td>Were the internal R&amp;D activities created or reinforced in the context of the project?</td>
<td></td>
</tr>
<tr>
<td>Did the partner reinforce internally the R&amp;D function?</td>
<td>OCES</td>
</tr>
</tbody>
</table>

Questionnaire, OCES | Coordinator |
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>20101 Entity's name</td>
<td></td>
</tr>
<tr>
<td>20161a Does the partner have intellectual/industrial property rights on the project results?</td>
<td></td>
</tr>
<tr>
<td></td>
<td>If yes, how are they explored?</td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td>20168 Did any of them came from other consortium partners?</td>
<td></td>
</tr>
</tbody>
</table>
## Function's allocation table

<table>
<thead>
<tr>
<th>Function</th>
<th>From Jan-00 to Jan-00</th>
<th>1901</th>
<th>1902</th>
<th>1903</th>
<th>1904</th>
<th>Partner's profile adequacy to the execution of this function</th>
</tr>
</thead>
<tbody>
<tr>
<td>20170 Coordination</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>20180 Funding</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>20190 Basic research</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>20200 Applied research</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>20210 Development</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>20220 Marketing &amp; Sales</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>20230 Maintenance &amp; Support</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>20240 Dissemination</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>20250 Consultancy</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>20260 Training</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>20270 IPR Protection</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>20280 Demonstration</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>20290 Test &amp; Validation</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
### General Information on the Partner

<table>
<thead>
<tr>
<th>Field</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>20101</td>
<td>Entity's name</td>
</tr>
<tr>
<td>20102</td>
<td>Address</td>
</tr>
<tr>
<td>20103</td>
<td>District</td>
</tr>
<tr>
<td>20104</td>
<td>NUT Region</td>
</tr>
<tr>
<td>20105</td>
<td>Entity type</td>
</tr>
<tr>
<td>20106</td>
<td>Partner's legal creation date</td>
</tr>
<tr>
<td>20107</td>
<td>Person responsible in the project's coordination</td>
</tr>
<tr>
<td>20108</td>
<td>Telephone</td>
</tr>
<tr>
<td>20109</td>
<td>E-mail address</td>
</tr>
<tr>
<td>20110</td>
<td>Position</td>
</tr>
<tr>
<td>20111</td>
<td>Education level</td>
</tr>
<tr>
<td>20112</td>
<td>Did the project manager have previous experience in research or innovation projects?</td>
</tr>
<tr>
<td>20113</td>
<td>Role performed by the entity</td>
</tr>
<tr>
<td></td>
<td>Funding role / Researcher / Developer / End-user</td>
</tr>
<tr>
<td>20120</td>
<td>If different, please specify</td>
</tr>
<tr>
<td>20121</td>
<td>CAE Activity sector</td>
</tr>
<tr>
<td>20122</td>
<td>SIC Activity sector</td>
</tr>
<tr>
<td>20123</td>
<td>Brief description of the main activity developed</td>
</tr>
</tbody>
</table>

**INESC Porto**

**OCES**

### Questionnaire, OCES

<table>
<thead>
<tr>
<th>Field</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>20101</td>
<td>Entity's name</td>
</tr>
<tr>
<td>20124</td>
<td>Turnover</td>
</tr>
<tr>
<td>20125</td>
<td>Exports</td>
</tr>
<tr>
<td>20126</td>
<td>Which is the number of employees, per education level:</td>
</tr>
<tr>
<td></td>
<td>0</td>
</tr>
<tr>
<td>20127</td>
<td>Primary School</td>
</tr>
<tr>
<td>20128</td>
<td>Secondary School</td>
</tr>
<tr>
<td>20129</td>
<td>License / Bachelor degree</td>
</tr>
<tr>
<td>20130</td>
<td>M.Sc. degree</td>
</tr>
<tr>
<td>20131</td>
<td>PhD</td>
</tr>
<tr>
<td>20132</td>
<td>Partner's budget for the project</td>
</tr>
<tr>
<td>20133</td>
<td>Partner's funding for the project</td>
</tr>
<tr>
<td>20134</td>
<td>Which was the partner's role in the creation of the project?</td>
</tr>
<tr>
<td>20135</td>
<td>Was it an internal team created to undertake the development of the project?</td>
</tr>
<tr>
<td>20136</td>
<td>Was the responsibility of the project formally assigned to a collaborator of the entity?</td>
</tr>
<tr>
<td>20137</td>
<td>Which was the coordinator's percentage of involvement in the project?</td>
</tr>
<tr>
<td>20138</td>
<td>Did the Board of Directors have a direct participation in project's management?</td>
</tr>
<tr>
<td>20139</td>
<td>Did the partner already have participated in innovation projects? If yes, please indicate the number of projects.</td>
</tr>
<tr>
<td>20140</td>
<td>Did the partner already have a R&amp;D department? If yes, please indicate the number of persons in that department.</td>
</tr>
</tbody>
</table>

**INESC Porto**

**OCES**
### Project's impact on the partner

#### Which was the impact of the project's results for the partner performing the end-user role?
- Increased turnover
- Increased internal market share
- Increased external market share
- Increased technological level
- Increased employees' education level
- Increased productivity
- Increased capacity to adapt to clients' demands

**FALSE**

#### Did the partner performing technology vendor role already have experience in the end-user activity sectors?
- Increased turnover
- Increased internal market share
- Increased external market share
- Increased technological level
- Increased employees' education level
- Increased productivity
- Increased capacity to adapt to clients' demands

**FALSE**

#### Did the R&D partner already have experience in the end-user activity sectors?
- Yes
- No

#### Was the cooperation relation with the Science&Technology institutions created or reinforced?
- Yes
- No

#### Did the partner participate in similar projects after the project ended?
- Yes
- No

#### Were the internal R&D activities created or reinforced in the context of the project?
- Yes
- No

#### Did the partner reinforce internally the R&D function?
- Yes
- No

---

### Questionnaire, OCES

#### Entity's name

---

#### Did the project have impact on the partner's image on the market?

---

#### Does the partner have intellectual/industrial property rights on the project results?
- Yes
- No

If yes, how are they explored?

- Within the scope of the normal activity
- By receiving royalties from the other partners

If different, please specify

- If not, which was the reason:
- The entity sold its property rights to the consortium?
- If different, please specify

---

#### Did you contract persons during project development? Please answer with the number of persons

---

#### Did any of them came from other consortium partners?
- Yes
- No

If yes, from which partners?

---
<table>
<thead>
<tr>
<th>Function</th>
<th>Involvement in tasks execution</th>
<th>Partner's profile adequacy to the execution of this function</th>
</tr>
</thead>
<tbody>
<tr>
<td>20170 Coordination</td>
<td>From Jan-00 to Jan-00</td>
<td>1901 1902 1903 1904</td>
</tr>
<tr>
<td>20180 Funding</td>
<td></td>
<td></td>
</tr>
<tr>
<td>20190 Basic research</td>
<td></td>
<td></td>
</tr>
<tr>
<td>20200 Applied research</td>
<td></td>
<td></td>
</tr>
<tr>
<td>20210 Development</td>
<td></td>
<td></td>
</tr>
<tr>
<td>20220 Marketing &amp; Sales</td>
<td></td>
<td></td>
</tr>
<tr>
<td>20230 Maintenance &amp; Support</td>
<td></td>
<td></td>
</tr>
<tr>
<td>20240 Dissemination</td>
<td></td>
<td></td>
</tr>
<tr>
<td>20250 Consultancy</td>
<td></td>
<td></td>
</tr>
<tr>
<td>20260 Training</td>
<td></td>
<td></td>
</tr>
<tr>
<td>20270 IPRI Protection</td>
<td></td>
<td></td>
</tr>
<tr>
<td>20280 Demonstration</td>
<td></td>
<td></td>
</tr>
<tr>
<td>20290 Test &amp; Validation</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

INESC Porto

OCES
### Results

#### Products

<table>
<thead>
<tr>
<th>Name(s)</th>
<th>Description</th>
<th>Innovation degree</th>
<th>Year</th>
<th>Market</th>
<th>Unit</th>
<th>From Jan-00 to Jan-00</th>
<th>1901</th>
<th>1902</th>
<th>1903</th>
<th>1904</th>
</tr>
</thead>
<tbody>
<tr>
<td>300</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Quant. Value</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>320</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Quant. Value</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>340</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Quant. Value</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>360</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Quant. Value</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

#### Licenses

<table>
<thead>
<tr>
<th>Number of contracts</th>
<th>From Jan-00 to Jan-00</th>
<th>1901</th>
<th>1902</th>
<th>1903</th>
<th>1904</th>
</tr>
</thead>
<tbody>
<tr>
<td>380</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>385</td>
<td>Value (Turnover)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

#### Associated services

<table>
<thead>
<tr>
<th>Value (Turnover)</th>
<th>From Jan-00 to Jan-00</th>
<th>1901</th>
<th>1902</th>
<th>1903</th>
<th>1904</th>
</tr>
</thead>
<tbody>
<tr>
<td>390</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

#### Patents

<table>
<thead>
<tr>
<th>Number</th>
<th>From Jan-00 to Jan-00</th>
<th>1901</th>
<th>1902</th>
<th>1903</th>
<th>1904</th>
</tr>
</thead>
<tbody>
<tr>
<td>395</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>400</td>
<td>Value (Turnover)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

#### Trademarks

<table>
<thead>
<tr>
<th>Number</th>
<th>From Jan-00 to Jan-00</th>
<th>1901</th>
<th>1902</th>
<th>1903</th>
<th>1904</th>
</tr>
</thead>
<tbody>
<tr>
<td>405</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>410</td>
<td>Value (Turnover)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### Questionnaire_OCES

<table>
<thead>
<tr>
<th>Number</th>
<th>Description</th>
<th>Results</th>
</tr>
</thead>
<tbody>
<tr>
<td>415</td>
<td>Number of spin-offs created</td>
<td></td>
</tr>
<tr>
<td>416</td>
<td>Number of new business units created</td>
<td></td>
</tr>
<tr>
<td>417</td>
<td>Number of M.Sc. degrees accomplished</td>
<td></td>
</tr>
<tr>
<td>418</td>
<td>Number of PhDs degrees accomplished</td>
<td></td>
</tr>
<tr>
<td>419</td>
<td>Number of published scientific articles</td>
<td></td>
</tr>
</tbody>
</table>

### Patents

<table>
<thead>
<tr>
<th>Question</th>
<th>Details</th>
</tr>
</thead>
<tbody>
<tr>
<td>420</td>
<td>Where did you ask the registration of the patent?</td>
</tr>
<tr>
<td>421</td>
<td>For which reasons the patent was not yet registered?</td>
</tr>
</tbody>
</table>
### Results' Exploitation

<table>
<thead>
<tr>
<th>Question</th>
<th>Options</th>
</tr>
</thead>
<tbody>
<tr>
<td>Are the results already in exploitation?</td>
<td></td>
</tr>
<tr>
<td>If yes,</td>
<td></td>
</tr>
<tr>
<td>The results were exploited by another partner which was not part of the initial consortium?</td>
<td><img src="image1" alt="Image" /></td>
</tr>
<tr>
<td>If yes, please indicate in which way:</td>
<td><img src="image2" alt="Image" /></td>
</tr>
<tr>
<td>By selling the results</td>
<td><img src="image3" alt="Image" /></td>
</tr>
<tr>
<td>By creating a new enterprise</td>
<td><img src="image4" alt="Image" /></td>
</tr>
<tr>
<td>Which are the main sectors in which project's results were applied?</td>
<td><img src="image5" alt="Image" /></td>
</tr>
<tr>
<td>In which other sectors the project's results could be also applied?</td>
<td><img src="image6" alt="Image" /></td>
</tr>
<tr>
<td>If not,</td>
<td></td>
</tr>
<tr>
<td>Which are the reasons for not commercially exploiting yet the project's results:</td>
<td><img src="image7" alt="Image" /></td>
</tr>
<tr>
<td>Gave up the project's objectives</td>
<td><img src="image8" alt="Image" /></td>
</tr>
</tbody>
</table>

---

### Results

<table>
<thead>
<tr>
<th>Question</th>
<th>Options</th>
</tr>
</thead>
<tbody>
<tr>
<td>There was no commercial exploitation because the situation changed</td>
<td><img src="image9" alt="Image" /></td>
</tr>
<tr>
<td>Misunderstandings inside the consortium did not allow its/their exploitation</td>
<td><img src="image10" alt="Image" /></td>
</tr>
<tr>
<td>Difficulties in the commercialization cycle</td>
<td><img src="image11" alt="Image" /></td>
</tr>
<tr>
<td>Difficulties generated by technical or certification norms did not allow its launching</td>
<td><img src="image12" alt="Image" /></td>
</tr>
<tr>
<td>Difficulties in obtaining the funding for the investments</td>
<td><img src="image13" alt="Image" /></td>
</tr>
<tr>
<td>Please specify, if different</td>
<td><img src="image14" alt="Image" /></td>
</tr>
<tr>
<td>Do you expect to commercially exploit the results in short time (less than 1 year)?</td>
<td><img src="image15" alt="Image" /></td>
</tr>
<tr>
<td>If yes, in which way</td>
<td><img src="image16" alt="Image" /></td>
</tr>
</tbody>
</table>
Annex A.2. Supporting Tables for the Questionnaire

Table A.2.1. Supporting tables – Introduction and Menu

<table>
<thead>
<tr>
<th>Nr. Crt.</th>
<th>Field name</th>
<th>Alternative answers</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Status</td>
<td>Under construction/ Under validation/ Finished</td>
</tr>
</tbody>
</table>

Table A.2.2. Supporting tables – Project

<table>
<thead>
<tr>
<th>Nr. Crt.</th>
<th>Question number</th>
<th>Alternative answers</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>109</td>
<td>Not applicable/ ICPME/ PRAXIS I&amp;D em consortio/ FCT/ PEDIP/ POE/ PRAXIS XXI/ IMIT/ PRODIBETA</td>
</tr>
<tr>
<td>2.</td>
<td>110</td>
<td>Quality of life/ IST/ GROWTH/ EE SD/ INCO2/ Innovation SMEs/ CRAFT/ Improving</td>
</tr>
<tr>
<td>3.</td>
<td>118</td>
<td>Not applicable/ All/ Some/ None</td>
</tr>
</tbody>
</table>

Table A.2.3. Supporting tables - Partners

<table>
<thead>
<tr>
<th>Nr. Crt.</th>
<th>Question number/ Field name</th>
<th>Alternative answers</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>X0105 University/ R&amp;D Institute/ Technological Center/ Enterprise/ Enterprise Association</td>
<td></td>
</tr>
<tr>
<td>2.</td>
<td>X0112 Primary school/ Secondary school/ License or bachelor degree/ M.Sc. degree/ PhD degree</td>
<td></td>
</tr>
<tr>
<td>3.</td>
<td>X0133 Not applicable/ Joined the project during its development/ Animator in project’s creation</td>
<td></td>
</tr>
<tr>
<td>4.</td>
<td>Involvement in tasks execution 2-High involvement/ 1- Medium Involvement/ 0- Without involvement</td>
<td></td>
</tr>
<tr>
<td>5.</td>
<td>Partner’s profile adequacy to the execution of this function 2-High/ 1-Medium</td>
<td></td>
</tr>
</tbody>
</table>

Note: X is a cardinal number (from 2 to 10) indicating the changing consortium partner.

Table A.2.4. Supporting tables - Results

<table>
<thead>
<tr>
<th>Nr. Crt.</th>
<th>Question number/ Field name</th>
<th>Alternative answers</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>421 Not applicable/ The product could not be patented/ The required deadline passed/ There is still the intention to make the registration request/ There is no interest in any patenting</td>
<td></td>
</tr>
<tr>
<td>2.</td>
<td>449 Not applicable/ Still trying/ Already gave up</td>
<td></td>
</tr>
<tr>
<td>3.</td>
<td>455 Not applicable/ By launching a new product/ By complementary developments</td>
<td></td>
</tr>
</tbody>
</table>
ANNEX B. National System of Governance of Innovation Policy

Figure B.1. National System of Governance of Innovation Policy

Source: European Trend chart on Innovation, March 2000

132
## Annex C. Survey Indicators

### Table C.1. PDIP Indicators

<table>
<thead>
<tr>
<th>Nr. Crt.</th>
<th>Indicator / Results</th>
<th>Corresponding Questionnaire Number</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>I. Project</td>
<td></td>
</tr>
<tr>
<td>1.</td>
<td>Total budget</td>
<td>106</td>
</tr>
<tr>
<td>2.</td>
<td>Average project budget and standard deviation</td>
<td>107</td>
</tr>
<tr>
<td>3.</td>
<td>Total funding</td>
<td></td>
</tr>
<tr>
<td>4.</td>
<td>Average total funding and standard deviation</td>
<td>108</td>
</tr>
<tr>
<td>5.</td>
<td>Number of partners per project</td>
<td></td>
</tr>
<tr>
<td>6.</td>
<td>Average number of partners per project</td>
<td></td>
</tr>
<tr>
<td>7.</td>
<td>Number and percentage of projects funded by a national funding program</td>
<td>109,111</td>
</tr>
<tr>
<td>8.</td>
<td>Number and percentage of projects funded by an European funding program</td>
<td>110</td>
</tr>
<tr>
<td>9.</td>
<td>Number and percentage of projects financed by a certain national funding program</td>
<td>109,111</td>
</tr>
<tr>
<td>10.</td>
<td>Planned project duration and standard deviation</td>
<td>112,113</td>
</tr>
<tr>
<td>11.</td>
<td>Average project planned duration</td>
<td>114,115</td>
</tr>
<tr>
<td>12.</td>
<td>Average project starting and ending delays</td>
<td>112,113,114,115</td>
</tr>
<tr>
<td>13.</td>
<td>Number and percentage of projects having a web page</td>
<td>117</td>
</tr>
<tr>
<td>14.</td>
<td>Key words list for product development innovation projects</td>
<td>116</td>
</tr>
<tr>
<td>15.</td>
<td>Number and percentage of projects were the partners had previous collaboration</td>
<td>118</td>
</tr>
<tr>
<td>16.</td>
<td>Average number of entities involved in the creation of the project</td>
<td>119</td>
</tr>
<tr>
<td>17.</td>
<td>Number and percentage of projects having an agreement on project results exploitation or intellectual property rights</td>
<td>120</td>
</tr>
<tr>
<td>18.</td>
<td>Number and percentage of projects that were the consequence of another project</td>
<td>121</td>
</tr>
<tr>
<td>19.</td>
<td>Number and percentage of projects created from roots</td>
<td>121</td>
</tr>
<tr>
<td>20.</td>
<td>Number and percentage of projects that generated a new project</td>
<td>123</td>
</tr>
<tr>
<td>21.</td>
<td>Number and percentage of projects using a dissemination network</td>
<td>124</td>
</tr>
<tr>
<td></td>
<td>II. Partners</td>
<td></td>
</tr>
<tr>
<td>22.</td>
<td>Identification and brief characterization of the entity: name, address, district, NUT region, partner’s legal creation date, SIC, CAE, brief description of the main activity, turnover, exports, number of employees considering their education level, and the identification of the project manager at entity level: name, position, contact</td>
<td>X0101,X0102,x0103,x0104,x0121,x0122,x0124,x0125</td>
</tr>
<tr>
<td>23.</td>
<td>Entity type</td>
<td>X0105</td>
</tr>
<tr>
<td>24.</td>
<td>Project manager education level (for the entity and for the project)</td>
<td>X0111</td>
</tr>
<tr>
<td>25.</td>
<td>The role(s) performed during the project</td>
<td>X0113</td>
</tr>
<tr>
<td>26.</td>
<td>The number of each entity type performing a certain role</td>
<td></td>
</tr>
<tr>
<td>27.</td>
<td>Partner’s budget</td>
<td>X0131</td>
</tr>
<tr>
<td>28.</td>
<td>Partner’s funding</td>
<td>X0132</td>
</tr>
<tr>
<td>29.</td>
<td>Number of employees per education level</td>
<td>X0126-30</td>
</tr>
<tr>
<td>30.</td>
<td>Number and percentage of entities (and type) which were animators in project creation</td>
<td>X0133</td>
</tr>
<tr>
<td>31.</td>
<td>Number and percentage of projects which associated during project execution</td>
<td>X0133</td>
</tr>
<tr>
<td>32.</td>
<td>Number and percentage of entities for which it was created an internal team for the development of the project</td>
<td>X0135</td>
</tr>
<tr>
<td>33.</td>
<td>Number and percentage of entities where the project management responsibility was formally assigned to an employee</td>
<td>X0136</td>
</tr>
<tr>
<td>Nr. Crt.</td>
<td>Indicator / Results</td>
<td>Corresponding Questionnaire Question Number</td>
</tr>
<tr>
<td>---------</td>
<td>-----------------------------------------------------------------------------------</td>
<td>---------------------------------------------</td>
</tr>
<tr>
<td>34.</td>
<td>Average value of the percentage of the project coordinator involvement in the project</td>
<td>X0137</td>
</tr>
<tr>
<td>35.</td>
<td>Number and percentage of entities where the Board had a direct involvement in the project management</td>
<td>X0138</td>
</tr>
<tr>
<td>36.</td>
<td>Number and percentage of entities (per project) with previous experience in innovation projects</td>
<td>X0139</td>
</tr>
<tr>
<td>37.</td>
<td>Average number of previous innovation projects developed by the entities</td>
<td>X0139</td>
</tr>
<tr>
<td>38.</td>
<td>Number and percentage of entities having a R&amp;D department</td>
<td>X0140</td>
</tr>
<tr>
<td>39.</td>
<td>Number and/or average of persons from the R&amp;D department</td>
<td>X0141</td>
</tr>
<tr>
<td></td>
<td>Number and type of end-user entities having an impact of project results:</td>
<td></td>
</tr>
<tr>
<td>41.</td>
<td>o Increased turnover</td>
<td>X0141</td>
</tr>
<tr>
<td>42.</td>
<td>o Increased internal market segment</td>
<td>X0142</td>
</tr>
<tr>
<td>43.</td>
<td>o Increased external market sector</td>
<td>X0143</td>
</tr>
<tr>
<td>44.</td>
<td>o Increased technological level</td>
<td>X0144</td>
</tr>
<tr>
<td>45.</td>
<td>o Increased employees’ education level</td>
<td>X0145</td>
</tr>
<tr>
<td>46.</td>
<td>o Increased productivity</td>
<td>X0146</td>
</tr>
<tr>
<td>47.</td>
<td>o Increased capacity to adapt to client’s demands</td>
<td>X0147</td>
</tr>
<tr>
<td>48.</td>
<td>Number and percentage of entities performing technology vendor role with previous experience in project results sectors</td>
<td>X0148</td>
</tr>
<tr>
<td></td>
<td>Number and type of entities performing technology vendor role having an impact of project results:</td>
<td></td>
</tr>
<tr>
<td>49.</td>
<td>o Increased turnover</td>
<td>X0149</td>
</tr>
<tr>
<td>50.</td>
<td>o Increased internal market segment</td>
<td>X0150</td>
</tr>
<tr>
<td>51.</td>
<td>o Increased external market sector</td>
<td>X0151</td>
</tr>
<tr>
<td>52.</td>
<td>o Increased technological level</td>
<td>X0152</td>
</tr>
<tr>
<td>53.</td>
<td>o Increased employees’ education level</td>
<td>X0153</td>
</tr>
<tr>
<td>54.</td>
<td>o Increased productivity</td>
<td>X0154</td>
</tr>
<tr>
<td>55.</td>
<td>o Increased capacity to adapt to client’s demands</td>
<td>X0155</td>
</tr>
<tr>
<td>56.</td>
<td>Number and percentage of entities performing the research role that had previous experience in these activity sectors</td>
<td>X0156</td>
</tr>
<tr>
<td>57.</td>
<td>Number and percentage of entities for which there were improved the relations with the Science and Technology institutions</td>
<td>X0157</td>
</tr>
<tr>
<td>58.</td>
<td>Number and percentage of partners that had similar projects after the project ended</td>
<td>X0158</td>
</tr>
<tr>
<td>59.</td>
<td>Number and percentage of entities for which there were created or reinforced the internal R&amp;D activities</td>
<td>X0159</td>
</tr>
<tr>
<td>60.</td>
<td>Number and percentage of entities that created a new R&amp;D department</td>
<td>X0160</td>
</tr>
<tr>
<td>61.</td>
<td>Number and percentage of entities with impact of the image on the market</td>
<td>X0161</td>
</tr>
<tr>
<td>62.</td>
<td>Number and percentage of partners having or not having intellectual and property rights on project results, briefly mentioning the reasons</td>
<td>X0161a-x0166</td>
</tr>
<tr>
<td>63.</td>
<td>Number and percentage of partners not having intellectual and property rights on project results, briefly mentioning the reasons</td>
<td>X0165-6</td>
</tr>
<tr>
<td>64.</td>
<td>Number and percentage of partners that contracted employees during the project</td>
<td>X0167</td>
</tr>
<tr>
<td>65.</td>
<td>Number and percentage of entities sub-contracting employees from another entity from the consortium (to look to the entity types between which there was made the transfer)</td>
<td>X0168-9</td>
</tr>
<tr>
<td>66.</td>
<td>The functions performed per entity type during the project execution and four years after</td>
<td>X0170—4 etc</td>
</tr>
<tr>
<td>67.</td>
<td>The adequacy of each entity type in performing a certain function</td>
<td>X0175.x0185 etc</td>
</tr>
<tr>
<td>Nr. Crt.</td>
<td>Indicator / Results</td>
<td>Corresponding Questionnaire Question Number</td>
</tr>
<tr>
<td>---------</td>
<td>-------------------------------------------------------------------------------------</td>
<td>---------------------------------------------</td>
</tr>
<tr>
<td>68</td>
<td>Average number of products obtained per project</td>
<td>300, 320, 340, 360</td>
</tr>
<tr>
<td>69</td>
<td>Total number of products obtained</td>
<td>300, 320, 340, 360</td>
</tr>
<tr>
<td>70</td>
<td>Total number of radical and incremental innovative products obtained</td>
<td></td>
</tr>
<tr>
<td>71</td>
<td>Total number of marketed products during the project execution and four years after</td>
<td>303, 322, 342, 362</td>
</tr>
<tr>
<td>72</td>
<td>Total turnover obtained during the project execution and four years after</td>
<td></td>
</tr>
<tr>
<td>73</td>
<td>Number, percentage and average number of projects obtaining licences during the project and four years after</td>
<td>380-384</td>
</tr>
<tr>
<td>74</td>
<td>The turnover obtained from licences - during the project and four years after</td>
<td>385-9</td>
</tr>
<tr>
<td>75</td>
<td>Number, percentage and average number of projects obtaining associated services during the project and four years after</td>
<td>390-4</td>
</tr>
<tr>
<td>76</td>
<td>The turnover obtained from the associated services</td>
<td>390-4</td>
</tr>
<tr>
<td>77</td>
<td>Number, percentage and average number of projects obtaining patents during the project and four years after</td>
<td>395-9</td>
</tr>
<tr>
<td>78</td>
<td>Turnover obtained from trademarks during the project and four years after</td>
<td>400-4</td>
</tr>
<tr>
<td>79</td>
<td>Number, percentage and average number of spin-offs created</td>
<td>415</td>
</tr>
<tr>
<td>80</td>
<td>Number, percentage and average number projects determining new business units</td>
<td>416</td>
</tr>
<tr>
<td>81</td>
<td>Number, percentage and average number of PhDs</td>
<td>418</td>
</tr>
<tr>
<td>82</td>
<td>Number, percentage and average number of Master degrees</td>
<td>417</td>
</tr>
<tr>
<td>83</td>
<td>Number, percentage and average number of publications obtained during the project</td>
<td>419</td>
</tr>
<tr>
<td>84</td>
<td>Reasons for not registering the patents</td>
<td>421</td>
</tr>
<tr>
<td>85</td>
<td>Number, percentage and average number of projects with results in exploitation</td>
<td>424</td>
</tr>
<tr>
<td>86</td>
<td>Number and percentage of patents registered in Portugal and outside Portugal</td>
<td>420</td>
</tr>
<tr>
<td>87</td>
<td>Sector impact: weather results were transferred to just one or to a limited number of companies (small impact), to a large number of companies in the same industry sector (causing a significant sector impact) or to more than one sector (multi-sector impact).</td>
<td>426, 432</td>
</tr>
<tr>
<td>88</td>
<td>Reasons for not exploiting yet the project results</td>
<td>435-53</td>
</tr>
<tr>
<td>89</td>
<td>Number and percentage of projects where it is expected the exploitation of the project results in less than 1 year</td>
<td>454</td>
</tr>
<tr>
<td>90</td>
<td>Number and percentage of projects where it is expected the exploitation of the project results in less than 1 year by complementary developments</td>
<td>456</td>
</tr>
<tr>
<td>91</td>
<td>Number and percentage of projects where it is expected the exploitation of the project results in less than 1 year by launching a new project</td>
<td>457</td>
</tr>
</tbody>
</table>
# Annex D. PDIP Keywords List

<table>
<thead>
<tr>
<th>Nr. Crt.</th>
<th>Keywords</th>
<th>Nr. Crt.</th>
<th>Keywords</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>3D</td>
<td>55</td>
<td>Manufacturing goods</td>
</tr>
<tr>
<td>2</td>
<td>3D modelling and digitalisation</td>
<td>56</td>
<td>Manufacturing operations</td>
</tr>
<tr>
<td>3</td>
<td>Applied thermo-dynamics</td>
<td>57</td>
<td>Measurement</td>
</tr>
<tr>
<td>4</td>
<td>Artificial vision</td>
<td>58</td>
<td>Mechanical forming device</td>
</tr>
<tr>
<td>5</td>
<td>Automatic inspection software</td>
<td>59</td>
<td>Mechanical presses</td>
</tr>
<tr>
<td>6</td>
<td>Automatic warehousing</td>
<td>60</td>
<td>Metal laser cutting machines</td>
</tr>
<tr>
<td>7</td>
<td>Automated management</td>
<td>61</td>
<td>Metallic matrix composites</td>
</tr>
<tr>
<td>8</td>
<td>Biomaterials</td>
<td>62</td>
<td>Micro-particles</td>
</tr>
<tr>
<td>9</td>
<td>Bone substitutes</td>
<td>63</td>
<td>MIG/MAG soldering</td>
</tr>
<tr>
<td>10</td>
<td>Buildings' technical management</td>
<td>64</td>
<td>Multipoint control</td>
</tr>
<tr>
<td>11</td>
<td>Business processes</td>
<td>65</td>
<td>Nano-technology</td>
</tr>
<tr>
<td>12</td>
<td>Cars and drivers timing</td>
<td>66</td>
<td>Network management</td>
</tr>
<tr>
<td>13</td>
<td>Ceramics</td>
<td>67</td>
<td>Oven control</td>
</tr>
<tr>
<td>14</td>
<td>Chirurgical instruments</td>
<td>68</td>
<td>Paper industry</td>
</tr>
<tr>
<td>15</td>
<td>Communication</td>
<td>69</td>
<td>Paraffin removal</td>
</tr>
<tr>
<td>16</td>
<td>Conformation tests</td>
<td>70</td>
<td>Parameter self-adjustment</td>
</tr>
<tr>
<td>17</td>
<td>Construction industry</td>
<td>71</td>
<td>Passengers' collective transport operational management</td>
</tr>
<tr>
<td>18</td>
<td>Controller</td>
<td>72</td>
<td>PET blow injection</td>
</tr>
<tr>
<td>19</td>
<td>Cork</td>
<td>73</td>
<td>Plastics</td>
</tr>
<tr>
<td>20</td>
<td>Cork boiling disinfections</td>
<td>74</td>
<td>Point-switching system</td>
</tr>
<tr>
<td>21</td>
<td>Customized garments</td>
<td>75</td>
<td>Polyamide</td>
</tr>
<tr>
<td>22</td>
<td>Cutting system</td>
<td>76</td>
<td>Production technology</td>
</tr>
<tr>
<td>23</td>
<td>Dangerous residues</td>
<td>77</td>
<td>Protocols</td>
</tr>
<tr>
<td>24</td>
<td>Data warehousing</td>
<td>78</td>
<td>Public transport information</td>
</tr>
<tr>
<td>25</td>
<td>Digital protection, distance protection and transformation protection relay</td>
<td>79</td>
<td>PUR</td>
</tr>
<tr>
<td>26</td>
<td>Digitalisation</td>
<td>80</td>
<td>Quality</td>
</tr>
<tr>
<td>27</td>
<td>Dimensional control</td>
<td>81</td>
<td>Quality control</td>
</tr>
<tr>
<td>28</td>
<td>Distribution</td>
<td>82</td>
<td>Quality excellence</td>
</tr>
<tr>
<td>29</td>
<td>DMS</td>
<td>83</td>
<td>Quality inspection</td>
</tr>
<tr>
<td>30</td>
<td>Documentation security</td>
<td>84</td>
<td>Reactive polyurethane glues</td>
</tr>
<tr>
<td>31</td>
<td>DOVID</td>
<td>85</td>
<td>Remote maintenance</td>
</tr>
<tr>
<td>32</td>
<td>Dusting down</td>
<td>86</td>
<td>Robot</td>
</tr>
<tr>
<td>33</td>
<td>Energy</td>
<td>87</td>
<td>Sample cutting</td>
</tr>
<tr>
<td>34</td>
<td>Energy systems</td>
<td>88</td>
<td>SCADA</td>
</tr>
<tr>
<td>35</td>
<td>Environment</td>
<td>89</td>
<td>Sealing forecast</td>
</tr>
<tr>
<td>36</td>
<td>EOVs</td>
<td>90</td>
<td>Shop-floor cell information system</td>
</tr>
<tr>
<td>37</td>
<td>Extraction</td>
<td>91</td>
<td>Show industry</td>
</tr>
<tr>
<td>38</td>
<td>File management</td>
<td>92</td>
<td>SIA</td>
</tr>
<tr>
<td>39</td>
<td>Fleet management</td>
<td>93</td>
<td>Sintering</td>
</tr>
<tr>
<td>40</td>
<td>Glazing machine</td>
<td>94</td>
<td>Skin marking</td>
</tr>
<tr>
<td>41</td>
<td>Glues</td>
<td>95</td>
<td>Software</td>
</tr>
<tr>
<td>42</td>
<td>Hardware</td>
<td>96</td>
<td>Supply Chain Management</td>
</tr>
<tr>
<td>43</td>
<td>Holography</td>
<td>97</td>
<td>Supply management</td>
</tr>
<tr>
<td>44</td>
<td>Hospital's residues</td>
<td>98</td>
<td>TCP/IP</td>
</tr>
<tr>
<td>45</td>
<td>Image processing</td>
<td>99</td>
<td>TCS</td>
</tr>
<tr>
<td>46</td>
<td>Industrial information systems</td>
<td>100</td>
<td>Technical cork stopsers</td>
</tr>
<tr>
<td>47</td>
<td>Information management</td>
<td>101</td>
<td>Transport systems planning</td>
</tr>
<tr>
<td>48</td>
<td>Injection moulds</td>
<td>102</td>
<td>TTCN</td>
</tr>
<tr>
<td>49</td>
<td>Interaction</td>
<td>103</td>
<td>Unfinished-products handling and storage</td>
</tr>
<tr>
<td>50</td>
<td>Internet</td>
<td>104</td>
<td>Visual inspection</td>
</tr>
<tr>
<td>51</td>
<td>Inverter</td>
<td>105</td>
<td>Water analysis</td>
</tr>
<tr>
<td>52</td>
<td>Laboratory tests</td>
<td>106</td>
<td>Wine analysis</td>
</tr>
<tr>
<td>53</td>
<td>Logistics</td>
<td>107</td>
<td>Wireless optic networks</td>
</tr>
<tr>
<td>54</td>
<td>Maintenance</td>
<td>108</td>
<td>Workflow</td>
</tr>
</tbody>
</table>
Annex E. Functions by Consortia Entities - Figures

E.1. Functions performed by consortia entities (high and medium level of involvement)

1. Coordination

2. Funding
3. Basic Research

4. Applied Research
5. Development

6. Marketing & Sales
7. Maintenance & Support

8. Dissemination
9. Consultancy

10. Training
11. Intellectual Property Rights Protection

![Graph showing intellectual property rights protection over time for different entities such as Enterprise Associations, Technological Centers, Enterprises, Research and development institutes, and Universities.]

12. Demonstration

![Graph showing demonstration activities over time for different entities such as Enterprise Associations, Technological Centers, Enterprises, Research and development institutes, and Universities.]

142
E.2. Functions performed by consortia entities (with high level of involvement)

1. Coordination
2. Funding

3. Basic Research
4. Applied Research

![Graph showing the distribution of applications over time for different types of organizations.]

5. Development

![Graph showing the distribution of applications over time for different types of organizations.]
6. Marketing & Sales

7. Maintenance & Support
8. Dissemination

9. Consultancy
10. Training

11. Intellectual Property Rights Protection
12. Demonstration

13. Test & Validation
Annex F. Results’ Key/Supporting Technology

Table F.1. Key/Supporting technology

<table>
<thead>
<tr>
<th>Nr. Crt.</th>
<th>Key/support technology</th>
<th>Number of projects</th>
<th>Percentage of projects</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Software technology</td>
<td>13</td>
<td>26.53%</td>
</tr>
<tr>
<td>2</td>
<td>Computer-based vision sensing technology</td>
<td>5</td>
<td>10.20%</td>
</tr>
<tr>
<td>3</td>
<td>Mechanical devices design technology</td>
<td>5</td>
<td>10.20%</td>
</tr>
<tr>
<td>4</td>
<td>Control of mechanical devices technology</td>
<td>4</td>
<td>8.16%</td>
</tr>
<tr>
<td>5</td>
<td>Water-jet technology</td>
<td>2</td>
<td>4.08%</td>
</tr>
<tr>
<td>6</td>
<td>Electrical/Electronics technology</td>
<td>2</td>
<td>4.08%</td>
</tr>
<tr>
<td>7</td>
<td>Control</td>
<td>2</td>
<td>4.08%</td>
</tr>
<tr>
<td>8</td>
<td>Factory/shop-floor communications technology</td>
<td>1</td>
<td>2.04%</td>
</tr>
<tr>
<td>9</td>
<td>Gel technology</td>
<td>1</td>
<td>2.04%</td>
</tr>
<tr>
<td>10</td>
<td>Laser scanning technology</td>
<td>1</td>
<td>2.04%</td>
</tr>
<tr>
<td>11</td>
<td>Chemical technology</td>
<td>1</td>
<td>2.04%</td>
</tr>
<tr>
<td>12</td>
<td>Composite materials</td>
<td>1</td>
<td>2.04%</td>
</tr>
<tr>
<td>13</td>
<td>Injection technique</td>
<td>1</td>
<td>2.04%</td>
</tr>
<tr>
<td>14</td>
<td>Mechanical and software technologies</td>
<td>1</td>
<td>2.04%</td>
</tr>
<tr>
<td>15</td>
<td>Nano-technology</td>
<td>1</td>
<td>2.04%</td>
</tr>
<tr>
<td>16</td>
<td>Laser-cutting technology</td>
<td>1</td>
<td>2.04%</td>
</tr>
<tr>
<td>18</td>
<td>Biological technology</td>
<td>1</td>
<td>2.04%</td>
</tr>
<tr>
<td>19</td>
<td>Sensing technology</td>
<td>1</td>
<td>2.04%</td>
</tr>
<tr>
<td>20</td>
<td>Robotics</td>
<td>1</td>
<td>2.04%</td>
</tr>
<tr>
<td>21</td>
<td>Coating technology</td>
<td>1</td>
<td>2.04%</td>
</tr>
<tr>
<td>22</td>
<td>On-line chemical analyser</td>
<td>1</td>
<td>2.04%</td>
</tr>
<tr>
<td>23</td>
<td>Optical technology</td>
<td>1</td>
<td>2.04%</td>
</tr>
<tr>
<td>24</td>
<td>Hardware-peripherals technologies</td>
<td>1</td>
<td>2.04%</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td></td>
<td><strong>49</strong></td>
<td><strong>100%</strong></td>
</tr>
</tbody>
</table>

Note: When calculating the percentage, the results were rounded to the nearest integer. The number of digits to round to is 2.