PROMOTING THE DEVELOPMENT OF LOCAL INNOVATION SYSTEMS

THE CASE OF MEDELLIN COLOMBIA

April 2015
THE ORGANISATION FOR ECONOMIC COOPERATION AND DEVELOPMENT

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# TABLE OF CONTENTS

Table of Acronyms ...................................................................................... 7
Acknowledgements ..................................................................................... 10

## Executive Summary

- Human Capital: Strategic Mainstay of The Local STI System .................. 13
- Intensification of R&D Investment to Promote the Socio-Economic Development of the Region .......................................................... 15
- Public Policies Geared to Promoting Demand for Innovative Products and Services .......................................................... 18
- Strategies to Attract STI-Intensive Investments .......................................... 20
- Strengths, Weaknesses, Opportunities and Threats of Medellin's Innovation System .......................................................... 22

## Foreword

- Data Collection Through an OECD Policy Questionnaire ......................... 25
- Local Diagnostic Report ........................................................................... 25
- Study Visits by the International Group of Experts ................................. 25
- Final Report ............................................................................................. 26

## Chapter 1: The Context

- Innovation Policies in Colombia .............................................................. 28
- Innovation Policy in Medellin ................................................................. 31
- Towards a New Innovation Policy Agenda for Medellin ......................... 33
- References ............................................................................................. 35

## Chapter 2: Human Capital: Strategic Enabler for the Local STI System

- Key Policy Issues ................................................................................... 38
- Swot Analysis ......................................................................................... 47
- Recommendations .................................................................................. 49
- References ............................................................................................. 67

## Chapter 3: Intensification of Investment in R&D Activities Oriented Towards the Socio-Economic Development of the Region

- Universities and Research Groups of Medellin ................................... 69
- Key Issues for Policy ............................................................................... 72
- Swot Analysis ......................................................................................... 79
- Recommendations .................................................................................. 79
- References ............................................................................................. 93

## Chapter 4: Promoting Business Innovation, Support for Entrepreneurs and Participation of Strategic Actors in STI Activities

- Encouragement and Coordination of Business-Driven Demand for STI ........................................................ 100
- Coordination Between the Local Supply of Knowledge and Investment Opportunities in STI .......................................................... 105
- Swot Analysis ......................................................................................... 106
- Recommendations .................................................................................. 107
Chapter 5: Public Policies to Promote Demand for Innovative Products and Services ............................................................... 121
Public Procurement as a Tool to Foster Innovation ...................................................................................................................... 122
Key Policy Issues .............................................................................................................................................................................. 124
Swot Analysis .................................................................................................................................................................................. 129
Recommendations .............................................................................................................................................................................. 130
References .......................................................................................................................................................................................... 137

Chapter 6: Strategies to Attract STI-Intensive Investments ......................................................................................................................... 139
Swot Analysis .......................................................................................................................................................................................... 144
Recommendations .................................................................................................................................................................................. 145
References .......................................................................................................................................................................................... 152

Annex A: Learning Models ................................................................................................................................................................. 153
Learning Model 1: Dual Vocational Training Programme, Germany .................................................................................................. 153
Learning Model 2: Research Centres of Excellence Programme, Singapore .......................................................................................... 156
Learning Model 3: Tax Incentives for Business Innovation And New Businesses: The French Young Innovative Companies Programme (JeI) ........................................................................................................................................... 162
Learning Model 4: Technology-Business Consortia (Cte), Chile ......................................................................................................... 164
Learning Model 5: Mixed Funds (Fomix): Promotion of Scientific and Technological Investment in Mexico .................................................................................................................................................................................. 168
Learning Model 6: Innovative Public Procurement Programme in Flanders, Belgium .............................................................................. 171
Learning Model 7: International R&D Centres of Excellence (Chile) .................................................................................................... 174

Annex B: Promoting the Development of Medellin’s Innovation System - Action Plan .................................................................................................................................................................................................................. 178
Introduction .......................................................................................................................................................................................... 178
Main Recommendations for Medellin’s Innovation Policy .................................................................................................................. 179
Analysis and Prioritisation Of Recommendations with Respect to Previous Conditions ...................................................................................................................................................................................................................................... 180
Main Recommendations for the Action Plan ........................................................................................................................................ 188
Detailed Description of the Selected Recommendations ........................................................................................................................................ 190
Conclusions .................................................................................................................................................................................................................................................. 206

Tables
Table 1. SWOT Analysis ............................................................................................................................................................................. 48
Table 2. Incremental and radical Innovation ........................................................................................................................................... 52
Table 3. Regional distribution of Colombian research groups classified by quality .................................................................................. 71
Table 4. Projects financed by the STI fund in Medellin and the rest of Antioquia .......................................................................................... 74
Table 5. Distribution of the research calls for projects by Colciencias, 2014 ............................................................................................ 75
Table 6. Colciencias Internationalisation programmes, 2014 call .......................................................................................................... 77
Table 7. SWOT Analysis ............................................................................................................................................................................. 79
Table 8. Main public instruments to support business investment in STI ..................................................................................................... 97
Table 9. New types of business under the Medellin Ciudad Cluster programme ........................................................................................ 99
Table 10. STI investment initiatives by Medellin-based corporations ........................................................................................................ 102
Table 11. SWOT Analysis ............................................................................................................................................................................. 107
Table 12. Comparison between cluster prioritisation and the smart specialisation strategy ................................................................... 110
Table 13.  SWOT analysis .................................................................................................................. 130
Table 14.  Key factors in Medellin’s strategy to attract investments in STI ........................................ 141
Table 15.  SWOT Analysis ............................................................................................................... 145
Table 16.  Relative position of Medellin according to relevant criteria ............................................. 151
Table 17.  Characteristics of the Centres of Excellence under the RCE programme, Singapore .......................................................... 160
Table 18.  Details of the research centres of foreign universities attracted by the Singapore CREATE programme .......................................................................................................................... 161
Table 19.  Main components of the Chilean CTE ............................................................................. 165
Table 20.  FOMIX’s main characteristics ......................................................................................... 168
Table 21.  Annual distribution of FOMIX mixed funds ..................................................................... 169
Table 22.  Main components of the Chilean International R&D Centres of Excellence programme .......................................................... 175

Figures

Figure 1.  Distribution of projects in relevant areas ......................................................................... 170

Boxes

Box 1.  OECD Recommendations for the national innovation system ........................................... 30
Box 2.  Ruta N as a catalyst for innovation in Medellin ................................................................. 32
Box 3.  The Antioquia section of the University-Government-Industry Committee (CUEE) .......... 42
Box 4.  The higher education system in Colombia ......................................................................... 43
Box 5.  The dual vocational education and training system in Germany ........................................ 53
Box 6.  The dual vocational education and training system in Denmark ....................................... 54
Box 7.  Co-operative education at the University of Waterloo in Canada ...................................... 57
Box 8.  The experience of the Canary Islands (Spain): Innovation enablers ................................. 61
Box 9.  The Danish Technology Partnership Programme .......................................................... 62
Box 10.  Experiences of coordination between the supply and demand of STI skills.................... 64
Box 11.  VINNOVA Mobility for Growth Programme ................................................................. 65
Box 12.  Examples of inclusive ICT-based innovations ................................................................. 78
Box 13.  International examples of Centres of Excellence programmes ..................................... 81
Box 14.  Singapore Centres of Excellence Programmes ................................................................ 83
Box 15.  Regional programmes to attract talent in Spain ............................................................. 89
Box 16.  European Commission's initiative on key enabling technologies (KETs) ....................... 111
Box 17.  Young Innovative Companies Programme - JEI (France). Tax incentives for business innovation and creation of new businesses ................................................................. 112
Box 18.  Austmine Programme for the development of highly innovative suppliers for the mining industry (Australia) ........................................................................................................... 114
Box 19.  Technology-Business Consortia (Chile) ......................................................................... 116
Box 20.  Multilevel Mixed Funds (Mexico) .................................................................................... 117
Box 21.  Public investment in social innovation in Medellin .......................................................... 127
Box 22.  ¿Quién se le mide? programme ....................................................................................... 128
Box 23.  The innovative public procurement programme of Flanders, Belgium ......................... 132
Box 24.  Innovative public procurement in the EU and Spain ...................................................... 134
Box 25.  Outstanding experiences of developing urban innovation districts ................................. 147
Box 26.  The case of Navarre and the accelerated construction of international networks with innovative regions .................................................................................................................. 149
Box 27.  International R&D Centres of Excellence Programme, Chile ....................................... 150
Box 28.  Table interpretation guide ............................................................................................. 180
### TABLE OF ACRONYMS

<table>
<thead>
<tr>
<th>Acronym</th>
<th>Full Name</th>
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<tr>
<td>ACI</td>
<td>Agencia de Cooperación e Inversión de Medellín y el Área Metropolitana</td>
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<td>ANDI</td>
<td>La Asociación Nacional de Empresarios de Colombia</td>
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<td>ANSPE</td>
<td>Agencia Nacional para la Superación de la Pobreza Extrema</td>
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<td>BANCOLDEX</td>
<td>Banco de Desarrollo Empresarial y Comercio Exterior de Colombia</td>
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<td>CDT</td>
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<td>CTA</td>
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<td>CUEE</td>
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<td>CVT</td>
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<td>ECLAC</td>
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<td>EPM</td>
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<td>FCTI</td>
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<tr>
<td>FTA</td>
<td>Free Trade Agreement</td>
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<td>Gross Domestic Product</td>
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<td>HEI</td>
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<td>ICETEX</td>
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<tr>
<td>ICT</td>
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<td>IDB</td>
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<td>KET</td>
<td>Key enabling technologies</td>
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<td>MSMEs</td>
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<td>RCI</td>
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<td>Red Nacional Académica de Tecnología Avanzada</td>
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<td>RII</td>
<td>Regional Innovation Initiative</td>
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<td>SENA</td>
<td>Servicio Nacional de Aprendizaje de Colombia</td>
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<tr>
<td>SENNOVA</td>
<td>Sistema de Investigación, Desarrollo Tecnológico e Innovación del SENA&lt;br&gt;SENA’s Research, Technological Development and Innovation System</td>
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<td>SMSCE</td>
<td>Sistema de monitoreo, seguimiento, control y evaluación del FCTI&lt;br&gt;Monitoring, follow-up, control and evaluation System for the FCTI Fund</td>
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<tr>
<td>SNCTI</td>
<td>Sistema Nacional de Ciencia, Tecnología e Innovación&lt;br&gt;National Science, Technology and Innovation System of Colombia</td>
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<tr>
<td>STI</td>
<td>Science, Technology and Innovation</td>
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<td>SWOT</td>
<td>Strengths, weaknesses, opportunities and threats</td>
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<td>UNE</td>
<td>UNE EPM Telecomunicaciones</td>
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<tr>
<td>VET</td>
<td>Vocational Education and Training</td>
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EXECUTIVE SUMMARY

Medellin has come out of the tunnel. It has gone from being known internationally merely for its high crime rates stemming from the conflict of drug cartels, and being ignored by global production networks, to being considered a successful example of urban transformation as a result of new educational policies, the integration of disadvantaged neighbourhoods, and a strong commitment to innovation. With 3.7 million inhabitants in its metropolitan area, the capital city of Antioquia is the second largest city in Colombia after Bogota. Medellin has the potential to take a quantitative and qualitative leap forward in the next few years thanks to its new development model based on innovation, but this will depend largely on whether it manages to ground its local development strategy in consistent and efficient innovation policies.

Medellin stands out in the Latin American context for its strong commitment to science, technology and innovation (STI), which lie at the core of its local development strategy. During the last two decades the city has undergone a profound transformation that still resonates. The city has increasingly concentrated its development agenda on business innovation as a lever of competitiveness and economic growth, and has built the institutional basis needed to efficiently promote this agenda. Today Medellin has an efficient and dynamic local innovation system, where the leadership of Ruta N has been outstanding. Ruta N is the local innovation agency created in 2009 with the mandate to implement the Strategic STI Plan 2011-2021, which ambitiously aims to transform Medellin into the Latin American capital of innovation. Not surprisingly, in 2013 Medellin was voted Innovative City of the Year by the Wall Street Journal, the Urban Land Institute and Citigroup.

The present work has been carried out in the wake of the recent publication of a larger report where national innovation policies are evaluated in the context of Colombia’s accession process to the OECD. This report, prepared by a team of international experts from the OECD / LEED, presents the results of an analysis of the current situation of Medellin’s innovation system conducted in order to guide the city’s future innovation agenda and propose a set of recommendations and policy options based on international experience. At a time such as this, when a growing number of cities and regions of Latin America are beginning to engage more fully in the design and implementation of their own innovation policies -rather than leaving them solely in the hands of the central government- it is particularly appropriate to carry out an in-depth examination of Medellin’s case as a model of success.

After an introductory chapter where the national and local context is described, the Review is structured around five thematic areas of outstanding importance for the analysis of Medellin’s innovation system: human capital, a prerequisite for any national or local innovation system (Chapter 2); public investment in R&D through universities and research and technological development centres (Chapter 3); promotion of business innovation and support to entrepreneurship (Chapter 4); demand-side innovation policies (Chapter 5); and attraction of foreign innovation-intensive businesses and institutions (Chapter 6).

In addition, the study identifies four strategic goals that are fundamental to the future development of Medellin’s innovation system, which will be referred to in every chapter. These areas are as follows:

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• **Multilevel governance:** Efficient mechanisms will have to be created to improve vertical coordination between the National Government, the departments and the municipalities; as well as horizontal coordination between ministries and public agencies, given that innovation directly affects all levels of political activity.

• **Smart specialisation:** It is advisable to concentrate the scarce financial and human resources available for science, technology and innovation in a few priority areas clearly identified on the basis of regional strengths and comparative advantages.

• **Social innovation:** Given the prevalence of poverty, inequality and the informal economy, new approaches are needed to better link technological progress with other social objectives so that the results of R&D are more inclusive.

• **Internationalisation:** If Medellin aspires to become internationally recognised for innovative capacity, it should improve its standing in global innovation networks through international collaboration in science and technology, and by attracting companies, institutions, funding and human capital.

Below, a summary of the main recommendations contained in each chapter is presented, followed by a table summarising the main strengths, weaknesses, opportunities and threats of Medellin’s innovation system.

Where relevant, recommendations include suggestions of an operational nature drawn from the Action Plan, the full version of which is appended to this Review (see Annex B).

**Human Capital: strategic mainstay of the local STI system**

In Medellin, as in the rest of Colombia, it is universities that are at the forefront of science, technology and innovation, while investment by the private sector remains low. Clearly, the development of the human capital of companies is paramount to reverse this situation and encourage entrepreneurs to invest in STI in the medium- and long-term.

In recent years, there has been a significant change in Medellin whereby academia, government and business have realised the urgency of establishing a platform that may serve as a local innovation-prone ecosystem. In this dynamic and evolving context, human capital, and the development and maintenance of skills and capabilities, with the involvement of all relevant stakeholders, are deemed of central importance. This shared vision has prompted several institutions and public funding agencies to join efforts to support programmes, projects and initiatives aimed at enhancing the role of human capital in innovation processes.

But Medellin's innovation system comprises countless players with different and sometimes overlapping functions. Currently the system is characterised by a variety of initiatives, discourses and visions. As a result, there continues to be insufficient coordination between the different players, which is particularly evident in the case of educational institutions.

Therefore, the strategic challenge of developing human capital rests upon the following premises:

• Creating a specific far-reaching vision of human capital, which must be shared by the relevant players and encompasses all activities aimed at developing and enhancing skills and capabilities;

• Developing an efficient and effective working methodology that is suited to the current context; and
- Strengthening the "structural" capacity to manage these processes, improving inter-agency coordination, in line with a multilevel governance approach.

**Recommendations**

Policies aimed at developing human capital to promote innovation should consider two fundamental perspectives: the generation of skilled human capital and active job placement policies. At the same time, the establishment of an efficient *multilevel governance* framework is a prerequisite for the implementation of coordinated actions for the development of innovation-oriented human capital in Medellin.

**Generation of qualified human capital**

- *Develop an action plan for human capital.* This involves bringing together the measures and actions taken to assess STI-related skills and capabilities under a systemic approach that considers human capital a complex issue requiring an integrated vision.

- *Strengthen coordination between education providers.* This requires taking steps aimed at establishing a system for coordinating the work of local actors in the fields of education, training, government and business to allow the creation of lasting synergies concerning STI-driven human capital.

- *Generate STI-qualified human capital in all companies.* To achieve this, human capital must be developed and strengthened through specifically designed measures, tailored to the needs of different types of firms, sectors, levels of technological acumen, proneness to innovation, size, etc. Strengthening human capital requires concrete and impactful activities such as:

  - The science, technology and innovation observatory should draw up annual reports on local and international academic and employment gaps; forecast future human capital needs; provide the necessary input to make sure that the generation of human capital is based on a rational knowledge of current and future needs; interact with the national level to provide for an integrated and coherent system.

  - The business community should conclude cooperation agreements with universities to: encourage university-industry exchanges, foster mutual learning and apprenticeships throughout the students’ academic career; participate in the development - together with academic institutions - of education curricula that meet the needs of the corporate world; design and implement life-long training programmes for company employees; and promote social and economic recognition of technical professionals.

  - Higher education institutions should award technical and professional qualifications that correspond to companies’ current and foreseeable needs; create university-industry exchange programmes to facilitate mobility of researchers and qualified STI personnel between businesses and advanced academic and educational institutions (through "collaborative" innovation projects, vouchers, apprenticeships); create programmes to develop cross-cutting skills (entrepreneurship, foreign languages, ICT, emotional intelligence, and innovation).

  - Another important aspect is to facilitate the connection of the innovation ecosystem with the school system so that students develop an entrepreneurial mindset focused on knowledge and social innovation.
Active job placement policies

- **Generate demand for innovation-oriented human capital.** This requires encouraging all companies (not only high-tech ones, but the local business system as a whole) to consider the recruitment of innovation-oriented human resources and to continuously train their workforce as a permanent strategic investment priority.

- **Balance the supply and demand of qualified personnel.** It is necessary to improve the ability to detect the skilled human capital needs of the business sector, also considering the unexpressed and potential demand. This demand tends to increase, thereby stimulating companies’ innovative dynamics. The supply side must also be addressed so that the qualifications of the personnel on offer meet the emerging demand.

Intensification of R&D investment to promote the socio-economic development of the region

The improvement of Medellin's innovation system requires the stepping up of R&D investments through new political strategies aimed at bolstering existing research groups, and attracting new projects and funding streams.

Various structural and contingent factors that provide a favourable scenario for the intensification of R&D investments are observed in Medellin:

- The growing formation of a critical mass in the scientific system and the sophistication of a complex institutional framework composed of both public and private actors;

- Coordination of political initiatives between different levels of government, particularly between Medellin and the Antioquia region;

- Recent encouraging creation of a new national royalties system, whereby 10% of the revenues from mining activities is to be allocated to a newly-established STI fund;

- The increasing reputation of the city in international circles as a Latin American leader in technological development.

Nonetheless, the local context is also characterised by the persistence of significant levels of poverty and inequality between different sectors of the population and different cities in the region of Antioquia; and by the prevalence of an informal economy and precarious employment. Specifically, a challenge that has become more relevant in recent years is the disarticulation between the city's target research areas and the needs of the region of Antioquia as a whole. Outside Medellin, Antioquia is mostly a rural region where agriculture and mining activities predominate. However, few research groups in universities in Medellin show an interest in those sectors. Moreover, although efforts are underway to support internationalisation, Medellin's innovation system is still too restrictive, which is a serious weakness that should be corrected in the future.

In recent years, universities in Medellin have focused on the development of research programmes adapted to the needs of local industry in collaboration with companies and public agencies. This university-government-industry collaboration has spurred the private sector to co-fund a wide variety of groups, institutes and research centres that cater for its needs. Although there are some 'islands of excellence' in Medellin, namely companies and university research groups that are integrated in the global economy, it must not be forgotten that the vast majority of firms in the region are not very innovative or
productive. The big challenge is to promote a form of inclusive innovation that does not increase social inequalities but rather provides new opportunities and economic benefits for all citizens.

Recommendations

First, as a general recommendation, this section echoes the principal message contained in the OECD Review of Colombia's Innovation Policy (OECD, 2014): the country should substantially increase its investment in science and technology to facilitate diversification of its economy, boost economic growth and address major societal challenges. A strategy to promote the increase in investment in STI that Medellin has recently begun to experiment with consists in the creation of the so-called Pacts for Innovation, whereby businesses, universities, research institutes and government commit themselves to increase investment in this area. Beyond this general recommendation this section advances the following specific recommendations:

- Strengthen existing research groups and encourage the establishment of centres of excellence to achieve sufficient critical mass. Objective and transparent criteria of evaluation should be introduced through the launch of a new programme of national centres of excellence endowed with substantial resources and a design more in line with the current needs of the system. This national scheme could be complemented by a programme involving local centres of excellence from Medellin that focused on technologies and sectors to be defined following the development of a smart specialisation strategy. For this it would be advisable to:
  - Establish a dynamic platform that allows identification of existing research centres with their quality ratings and contact person. The platform must be continuously updated so as to facilitate exchanges between national and international research groups and centres.
  - Define a smart specialisation strategy and select priority technologies for centres of excellence.
  - Make available adequate funds to launch a municipal programme to support centres of excellence that can be maintained over a horizon of 10 years.
  - Strengthen research groups and encourage them to embrace social innovation.

- Foster social innovation and reinforce ties between Medellin's research agenda and the needs of the region of Antioquia, consolidating the existing close coordination between the city's Mayor and the Governor of the department. It is also of essence to strengthen the social innovation capabilities of different players in the system, as certain knowledge and skills-related gaps have been identified in small and medium enterprises.

- Improve multilevel department-municipality coordination, particularly in connection with the new royalty fund, in order to exploit synergies, avoid duplication and attract more funds for R&D to Medellin. To achieve this the following specific recommendations are proposed:
  - Promote projects that can demonstrate impact, effect or applicability regardless of the city or region in which they may be developed in order to leverage the cities’ installed capacity and increase the projects’ repercussion.
  - Promote the development of collaborative projects between regions. Colciencias could make it mandatory to cooperate in certain cases where overlaps or opportunities to exploit synergies are identified.
EXECUTIVE SUMMARY

PROMOTING THE DEVELOPMENT OF LOCAL INNOVATION SYSTEMS: THE CASE OF MEDELLIN, COLOMBIA

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- Strengthen the evaluative competences of Colciencias as an evaluation agency, without prejudice that the regions should continue to participate in the articulation and initial selection of projects. Establish a more automatic grant renewal system so as to simplify the administrative procedure involved. The aim is to provide more stable funding to the best projects, so that they are not affected by changes of government.

- Promote a Regional Pact that stabilises long-term relationships between Medellin and Antioquia through a new royalty management model. Strengthen the participation of CUEE and garner the support of the chambers of commerce for the initial evaluation of projects. Generate stimuli to ensure that a percentage of the royalties levied is allocated to collaborative projects with companies.

- Promote the internationalisation of the regional innovation system and attract funding, researchers, and international research projects.

Promotion of business innovation, entrepreneurial support and participation of strategic players in STI activities

Despite the good performance of the Colombian economy during the last decade in terms of economic expansion and export growth, and although progress has been made in social issues, Colombia's performance in the field of innovation is rather weak, with the business and entrepreneurial sectors still playing a somewhat peripheral role in the system. The country must reverse this situation and place the business sector at the heart of the innovation system.

Medellin has developed a growing critical mass of institutional actors, which positions the city favourably in terms of density of its local innovation system as compared to other metropolises in Colombia and Latin America. The city is home to at least large eight business conglomerates and boasts companies with significant growth rates, recognised nationwide leadership and significant export potential. During the last decade, some city's large companies have significantly increased their R&D activity.

In recent years, several initiatives have been deployed to promote the emergence of new technology-based companies. In fact, Medellin has developed pioneering initiatives in this area such as CREAME's InnCelerR, Cultura E and Parque E, among others. There are now a growing number of providers of smart capital (seed and venture capital funds) and non-financial services that have turned Medellin into probably the most important urban ecosystem for dynamic entrepreneurship in Colombia and one of the most important ones in Latin America.

However, an examination of the funding available for STI entrepreneurial projects in Medellin reveals poor coordination between the relevant institutions, and a tendency towards duplication and fragmentation of efforts. Different public institutions manage a large number of instruments and publish a variety of calls for projects, which are often plagued by design, implementation and coordination problems.

Recommendations

In order to enhance Medellin's capabilities and conditions to promote business investment in STI, the following is proposed:

- Promote a smart specialisation strategy in specific business areas and industries that may help position local firms in specific global markets.
• Foster the establishment of knowledge-based enterprises able to meet the needs of priority local clusters and their target markets.

• Create a more conducive environment to highly innovative technology-based start-ups.

In order to directly stimulate demand for business innovation, the following recommendations are proposed:

• Implement a regular co-funding programme for innovative projects submitted by SMEs and local social organisations.

• Promote and support programmes aimed at developing highly innovative local suppliers and, at the same time, identify and deploy technological dissemination initiatives specifically targeted at SMEs, taking into account the standards and requirements of Medellin-based multilatinas and global companies.

Finally, in order to balance supply and demand for innovation, several recommendations are proposed:

• Promote the establishment and operation of triple helix programmes in order to co-financing the development of technological roadmaps, encouraging the collaborative participation of universities, R&D centres and businesses through Regional Innovation Initiatives (RIIs).

• Identify, by means of RIIs, relevant gaps that may hamper progress in the different roadmaps. Ruta N will launch calls for projects where participant suppliers and users of STI collaboratively resolve problems in the ecosystem using key enabling technologies. It is also essential to guide and empower communities to make working decisions and engage in continuous team-based projects aimed at addressing ecosystem challenges without creating administrative red tape.

• Establish new multilevel trust funds ("mixed funds") to encourage investment and diversified financing sources at all stages of the innovation process. Although these may vary according to the type of business, its level of development and its capital requirements, these funds should orient to support enabling investments and joint R&D&I initiatives between universities, research and technological development centres, and companies. Mixed funds can adopt diverse shapes: private equity funds, angel investor networks, promotion, mezzanine financing, loans, etc. They should be linked directly with RIIs in order to focus on value-added projects prioritised by target communities. In addition, existing funds should be strengthened and the legal conditions on private funding made more flexible.

• Create and make available platforms and channels that may bring together the supply of Medellin-based smart capital and local initiatives or enterprising projects with high growth potential.

Public policies geared to promoting demand for innovative products and services

Demand-side innovation policies can be articulated through various policy instruments, the most prominent of which are public procurement of innovative products and services; the development of new regulations and standards that promote business innovation; the availability of tax incentives and subsidies to promote the adoption of innovative products and services; and the creation of an innovative culture in society. The current situation, together with the increase in the public funds available to boost innovation,
open new windows of opportunity for the implementation of public policies geared to promoting demand for innovation in Medellin.

Demand-side innovation policies can make a very significant contribution to achieving the four strategic goals identified above by: more clearly orienting Medellin's technological development toward social innovation as well as to a number of cross-cutting technologies defined as imperative in the context of a new smart specialisation strategy; requiring the setting up of an appropriate multilevel governance framework to facilitate interaction between local, regional and national authorities; and finally, gearing demand policies towards internationalisation, especially in the light of free trade agreements (FTAs).

**Recommendations**

- The main recommendation is to develop a new innovative public procurement programme that establishes a more effective link between innovation policy and social needs. To achieve this, steps must be taken to:
  - Appoint a working group and a specific person within Ruta N responsible for establishing the system and developing reference guidelines, in close coordination with the Office for Procurement and Contractual Performance of Medellin City Council;
  - Implement an awareness-raising, education and training plan aimed at both the public administration and potential and current contractors;
  - Post the challenges and problems faced by the city, together with the budget available to the various secretariats to address them, on platforms where national and international companies, research groups and universities can submit formal proposals for solutions;
  - Engage in pre-commercial procurement processes through competitive dialogue. The first step should be to draw up a shortlist of potential suppliers, with whom to establish a closer dialogue to better define the most appropriate solutions, which should subsequently be integrated into the specifications of public tenders;
  - Develop a user-guide or an operating manual of innovative public procurement aimed at both public administrations and bidding enterprises.

**Other recommendations**

- Explore areas where municipal regulations can influence private demand for innovative products and services;
- Develop programmes to address specific market needs;
- Propose new initiatives to promote green technologies;
- Ensure that companies participate in and benefit from online government programmes;
- Create programmes to enable firms to benefit from new FTAs;
- Promote the development of e-learning platforms and programmes by Medellin-based universities;
- Improve the integration of Ruta N’s Mi Medellin platform (see Chapter 5) with public bidding processes so that results do not remain at the prototype stage but are put into practice;

- Encourage public procurement aimed at modernising the public health system;

- Consider creating new tax incentives for companies that purchase innovative products, equipment, or technological services.

- Encourage citizens to acquire the relevant knowledge so that demand arises from the grass roots and, at the same time, it becomes more attractive to establish technology-based companies in the city.

### Strategies to attract STI-intensive investments

Recent developments have substantially improved the standing of Medellin in the national and Latin American context as an attractive destination for STI-intensive investment, both corporate and institutional. One of the most promising initiatives recently undertaken to this purpose has been the development of the Medellinnovation district, a new area in the north of the city that offers companies and research centres that settle there a number of fiscal and financial incentives as well as support services and the promise of an environment that is highly conducive to the development of innovative projects. Since its inception, Ruta N has strategically strived to attract innovation and technology-based companies to Medellin, particularly through the so-called Landing programme. These and other efforts have so far succeeded in attracting to the city two global high-tech companies such as Hewlett Packard and Kimberly Clark as well as other smaller-scale but equally significant R&D and innovation-intensive business investments.

Medellin now meets the conditions to make the most of the foreign capital flowing into the city for the development of innovation activities. The city possesses a well-established local business base; a strategic framework of leading public and private institutions that have a shared view of the STI-intensive sectors that should be considered a priority for productive development; a base of universities and R&D centres boasting technology transfer platforms; and a wide range of financial and non-financial services available to companies. However, both local and external companies in Medellin that have the capacity to innovate recognise that the availability of advanced human capital, sophisticated technological specialisation and English-language skills is still limited. They are also aware that the city offers no relative superlative advantages in terms of location, physical connectivity or proximity and accessibility to ports and airports as compared with foreign cities like San Jose or Panama City or even other Colombian cities like the capital Bogota or Barranquilla. This limitation mandates that the local innovation system should be endowed with additional attributes.

### Recommendations

Medellin’s remarkable progress in recent years, in terms of its visibility and international reputation as an attractive destination for STI-related investment and enterprises, must be sustained and intensified in the future through a focused strategy aimed at increasing the inflow of innovative businesses to the city.

The following are recommendations for potential new elements that may be included in the strategy:

- **Strengthen and provide international guidance to the Medellinnovation district project by considering the management and development experience of European regions that have successfully implemented projects to create innovative technological parks or districts.**
Elaborate further on Medellin’s marketing strategy and international standing as a destination for STI-intensive investment. In view of the progress and success obtained, local stakeholders must embark on a new phase where the results obtained are recognised and actively disseminated, with special focus on key markets (e.g., West and East coasts of the USA, Asia Pacific, Spain, Brazil and Southern Cone, among others) which are defined with a view to exploring potential business alliances, partnerships and opportunities for direct investment.

Strengthen the international profile of the Cooperation and Investment Agency of Medellin (ACI), promoting closer links with Ruta N so as to attract STI-intensive investments. Medellin has all the features and attributes required to become a magnet for STI-intensive investment. A strategy in this regard requires close collaboration between Ruta N and ACI, whose capabilities and functions are perfectly complementary.

Implement a programme geared to attracting, managing and retaining business and entrepreneurial talent. The creation of an ecosystem that supports innovative entrepreneurship would attract entrepreneurial talent to the city from other regions of Colombia and from neighbouring countries. On this basis, Ruta N and ACI should team up to establish an international programme for managing and recruiting human resources. Such an initiative could take the form of a council made up of leading figures from the public and private sectors and from academia. These would act as role models for the Talento Medellin initiative and coordinate corporate policies in this area promoted by multilatinas and multinational companies already established in the city.

Attract international corporate excellence skills in STI. The increase in the critical mass of multinational corporations and multilatinas in Medellin, each with their own capabilities and STI networks, opens the possibility of taking on greater challenges in the medium-term such as developing schemes to co-finance the establishment of incremental capacity and designing R&D plans. To leverage this installed capacity a competitive intelligence study should be conducted to benchmark different policies aimed at attracting and stimulating investment. This would contribute to the development of a strategy intended to facilitate the establishment of corporate centres of excellence in Medellin and lure national and foreign researchers residing abroad.

Strengthen Medellin’s leadership among Latin American cities in the field of urban development and quality of life. Medellin was chosen as Latin America’s 13th most attractive city for investment out of a total of 48 cities in Latin America and the Caribbean2. Medellin's international standing must be balanced by local “inward-looking” action aimed at improving and continuously monitoring aspects of the local business and innovation environment where weaknesses have been detected. This requires designing an ambitious urban development strategy, which was widely recognised during the seventh session of the World Urban Forum held in Medellin in April 2014. Such a strategy, which would confirm the city as a Latin American leader in the field, would focus on activities aimed at:

- Increasing the visibility of the indicators and achievements that reflect the relative strengths of Medellin in the realm of urban development.

- Developing a national and international agenda of regular events associated with urban development, quality of life and the knowledge economy.

### Strengths, Weaknesses, Opportunities and Threats of Medellin's innovation system

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<thead>
<tr>
<th>STRENGTHS</th>
<th>OPPORTUNITIES</th>
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<tr>
<td><strong>Human Capital</strong></td>
<td>Insertion of the &quot;Medellin system&quot; into the context of globalisation of STI systems, which results in the potential to strengthen human capital; Availability of resources: i. to strengthen the supply of STI-related skills, capabilities and talents; ii. to boost demand for skilled employment.</td>
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<td>Consolidated system of education, training and research institutions that provide STI-qualified human resources; Presence of leading innovation-intensive companies that stimulate the local training offer, especially at tertiary and more advanced levels.</td>
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<tr>
<td><strong>Public investment in R&amp;D</strong></td>
<td>Ability to absorb more resources from the new national research support programmes; Persistent commitment to social innovation.</td>
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<tr>
<td>Presence of some of the main universities and public research centres in the country; Recent improvements in the operation of the regional innovation system.</td>
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<tr>
<td><strong>Promotion of business innovation</strong></td>
<td>Smart specialisation strategy aimed at capturing global market opportunities (based on the Medellin Ciudad Cluster programme) Recent creation of a significant number of private and mixed investment funds designed to make capital available to innovative ventures Broad base of SMEs that could gradually adopt innovative practices.</td>
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<tr>
<td>Existence of a segment of larger and more global companies that generate a demand for innovation Ruta N's role as the main player in the STI Plan, as a governance paragon, facilitator and strategic enabler of the local STI system.</td>
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<tr>
<td><strong>Demand-side innovation policies</strong></td>
<td>Ambitious public investment projects in the pipeline to upgrade the city and make it more innovative Greater openness to international trade as a result of new FTAs</td>
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<tr>
<td>Recent efforts to promote an innovative culture Success of Medellin's urban transformation during the last decade Participation of companies and civil society in competitions to provide innovative solutions</td>
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<td><strong>Attracting foreign companies and institutions</strong></td>
<td>Progress and recognition achieved by Medellin as an attractive destination for global companies Recent articulation of a local supply of smart capital to finance young companies, which reinforces the possibility that external STI-intensive start-ups may want to set up shop in Medellin The growing reputation of Medellin as a regional leader in the field of social innovation and urban development contributes to its ability to attract talent and investments in STI</td>
</tr>
<tr>
<td>Medellinnovation district flagship project Existence of a range of differentiated incentives for STI-intensive and dynamic companies wishing to establish themselves in Medellin Portfolio of relevant case-studies on the installation of multinational companies in the city</td>
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## WEAKNESSES

### Human Capital
- Weak coordination between the various local educational institutions and between these and the labour market.
- Multilevel governance fails to support the local innovation system with effective mechanisms.
- Gap between cutting-edge companies (multinationals and multilatinas) and most other firms (MSMEs) in Medellin.
- Limited mobility of human resources between triple helix actors and weak spillover effect.

### Public investment in R&D
- Insufficient critical mass and fragmentation of research efforts.
- Dislocation between Medellin's priority research areas and the needs of the region of Antioquia.
- Limited internationalisation of the regional innovation system.

### Promotion of business innovation
- Inconsistency and limited reach of public instruments available to promote business investment in STI.
- Limited scope of the current areas of collaboration between research groups and the business sector.
- Legal restrictions on spin-offs from public sector R&D efforts.
- Significant number of micro and small businesses that operate informally, with low productivity and high job insecurity.

### Demand-side innovation policies
- Absence of a clear regulatory framework for innovative public procurement
- Limited use of regulations and standards as tools to foster innovation

### Attracting foreign companies and institutions
- Poor performance of the city in terms of ease of doing business
- Limitations and mismatches in the local supply of advanced human capital and skilled workforce

## THREATS

### Prevalence of centrifugal dynamics and disruptive competition between local actors involved in the generation, strengthening and utilisation of human capital.

### Institutional inconsistencies that favour a short-termist attitude that weakens the major initiatives underway aimed at the structural development, strengthening and consolidation of human capital for the local STI system.

### Risk of neglecting basic research.

### The economic and social returns of R&D require time and continuity.

### Low deal flow of new dynamic high potential entrepreneurial initiatives, considering the high current availability of venture capital.

### Risk that the expansion of the universe of local companies with systematic innovation capacity may be too modest or too slow to reduce the current productivity gaps between different sectors.

### Corruption problems may hinder the development of a new innovative public procurement programme.

### The vast majority of enterprises in Medellin lack the technological capabilities needed to take advantage of demand-side innovation policies.

### Emergence of competing cities in Colombia and neighbouring countries as preferred destinations for R&D-related funding, given their strengths in the field of logistics and their decision to strengthen some of their other attributes (Panama City, San Jose, Barranquilla, Bogota, among others)

### Urban growth may in the future become a source of diseconomies of scale and reduced quality of life.
FOREWORD

Policies to promote innovation should take into account the rapid changes in the global economy and the ongoing transformation of innovation processes. To successfully travel the path from invention to innovation a series of complementary activities are required, including organisational changes; training at company level; and performance of implementation, marketing and design tests among others. Innovation is currently much more than research and development (R&D), although R&D remains a vital component. Innovation rarely occurs in isolation; it is usually a highly interactive collaborative process that involves an ever-growing and diverse network of actors, institutions and individuals. Moreover, the continuous emergence of new and important stakeholders adds to the already complex and multifaceted international innovation landscape.

The current context has intensified trends that were already underway in the past, which makes it even more essential that innovation policies should be appropriate, coherent and inclusive. More than ever, the recovery of growth and competitiveness are the main objectives of innovation policy. Such a policy should address social and environmental challenges of increasing magnitude and importance. Thus, it is necessary to rethink and re-create innovation policies in order to go beyond policies focused just on the supply of R&D and other specific technologies to advance towards a more systemic approach that takes into account the various players and factors influencing the development of innovation as well as policies aimed at demand itself. Thus, the policy objective should not be innovation as such, but its application to improve the lives of individuals and society at large.

This study is the result of an express request by Ruta N, on behalf of the authorities of the city of Medellin, and was drawn up at the OECD LEED Centre for Local Development in Trento, Italy. Its objective was to make a diagnosis of the current situation of the innovation system in Medellin with a view to informing the future science, technology and innovation policy agenda, offering a series of recommendations and alternatives based on international experience.

More specifically, the report:

- provides an independent and comparative assessment of the overall results of the innovation system of the city of Medellin;
- identifies areas where improvements can be made to the system; and
- makes recommendations on how government policies can contribute to these improvements, leveraging the experience of other OECD countries and the evidence arising from the implementation of other processes, systems and public innovation policies.

The final document is structured around six chapters. Chapter 1 provides a brief introduction to the local context, particularly Medellin's innovation system, and defines the four strategic directions that should guide its development. Chapter 2 focuses on human capital, which is the essential foundation upon which any national or regional innovation system should be built. Chapter 3 analyses public investment in R&D through universities and research and technological development centres. Chapter 4 discusses business innovation and entrepreneurship. Chapter 5 addresses demand-side innovation policies, with a
focus on public procurement as a tool to promote innovation. Finally, Chapter 6 focuses on attraction of foreign innovation-intensive companies and institutions.

The document is complemented by an annex that contains a selection of representative cases from international experiences intended to serve as learning models and a source of inspiration for the development of Medellin’s innovation policy.

Finally, an action plan is proposed in annex, which aims to guide the implementation of the activities required to materialise the guidelines proposed in the recommendations of this study.

This Review is intended to be of particular relevance for a wide range of national and international stakeholders interested in what happens in Colombia and particularly in the city of Medellin; including government officials, entrepreneurs and researchers, and the general public. It also aims to make use of the dissemination of the OECD communication and media platform to provide an accessible and comprehensive picture of Medellin’s innovation system to a global audience.

In specific terms, the study is mainly based on the observations and recommendations made in the course of the discussions conducted in the framework of a peer review process carried out by the OECD LEED Centre for Local Development in collaboration with various local actors.

A relevant input for the final report came from the responses of Colombian authorities to a questionnaire developed by the OECD that was administered at the beginning of the research process, as well as from the result of an extensive series of interviews with the main players in the local innovation system during two study visits made by an international group of OECD experts to Medellin.

The key components of the methodology are briefly described below:

**Data collection through an OECD policy questionnaire**

The local team, led by Professor Mario Vargas (Llanogrande Campus, EAFIT University), was responsible for administering an OECD policy questionnaire to the leading authorities in Colombia and Medellin involved in the latter’s innovation system. The data obtained from the different sections of the questionnaire were used to prepare both the local diagnostic report and, subsequently, the final report.

**Local diagnostic report**

The diagnostic report, also prepared by the local team of experts from the Llanogrande Campus of EAFIT University, provides an initial schematic-analytical description of the characteristics and key elements of Medellin's innovation system (including a SWOT analysis) and a description of the major socio-economic and political problems affecting the broader context within which it operates.

**Study visits by the international group of experts**

The Directorate of the OECD LEED Centre led an international panel of experts who paid two one-week external evaluation visits to Medellin. The first of these took place from 4th to 8th of November 2013, and the second from 24th to 28th of March 2014. During these study visits, the Director of the OECD LEED Centre together with international experts interviewed several policymakers at local, regional and national level, as well as other important stakeholders of Medellin’s innovation system. The interviews covered a wide range of topics and addressed different aspects related to the development of the system in the region and to the existing policies for promoting and strengthening it. Subsequently, a second visit was paid to present and validate the initial draft containing preliminary conclusions and recommendations.
Final report

The Directorate of the OECD LEED Centre for Local Development in Trento prepared this final report based on the responses to the OECD policy questionnaire; the results of the local diagnostic report; and the study visits made by the international group of experts. The report contains both an in-depth analysis of Medellin’s innovation system and a series of recommendations to develop and implement specific public policies at the local level in coordination with other levels of government. Such policies should be informed by best practices and examples from other regions in the world that have successfully addressed similar problems. International cases are particularly useful as validation of the public policy recommendations suggested in the report.
CHAPTER 1

THE CONTEXT

With a population of about 46.5 million people, Colombia is the third most populated country in Latin America after Brazil and Mexico. In 2012 it was the fourth largest economy in the region after Brazil, Mexico and Argentina, with a GDP of USD 369.6 billion (current, 2012) according to the World Bank (although the latest estimates indicate that the size of the Colombian economy has overtaken that of Argentina, becoming the third in the region). Despite major advances in the last decade, Colombia’s per capita income is still low compared to other countries in the region, social inequalities remain extreme, and poverty persists among large sections of the population. Colombia is currently in the process of accession to the OECD, which represents an excellent opportunity to review public policies in order to spur the economy and improve the quality of life of its citizens.

In recent years there has been a structural change in the Colombian economy, with a progressive contraction of manufacturing accompanied by a strong increase in the weight of the mining sector (including oil). That greater weight of the mining sector is explained by a strong increase in exports, inflows of foreign capital, and rising prices of raw materials. Although it has undoubtedly contributed to economic growth, this structural change raises doubts on the sustainability of the Colombian economic model and its international competitiveness, besides representing a potential barrier in the progress towards a more inclusive growth due to the low employment intensity of the minerals sector. Additionally, the trend toward currency appreciation accompanying the surge in exports of minerals endangers the future competitiveness of other industries and tradable services.

Against this context, innovation is becoming increasingly relevant as a path to increase productivity in current economic activities as well as to promote a gradual diversification of the economy towards new more knowledge-intensive activities with higher added value. Innovation is essential, first, to support the generation of employment and income in an urban population in constant growth and, secondly, to improve the quality and expand the range of agricultural products produced in rural areas. This would unquestionably make it easier to meet the expectations of improving rural livelihoods following the long-awaited cease of armed conflicts linked to drug trafficking and the lower insecurity levels in rural areas. Innovation can also be seen as a way to achieve more inclusive and environmentally sustainable economic growth (OECD, 2010).

However, Colombia is lagging substantially behind in the areas of science, technology and innovation (STI), not only compared to OECD countries but also in relation to other countries in Latin America. Indeed, during the last decade total R&D expenditure stubbornly remained below 0.2% of GDP, which represents about a quarter of the Latin American average (OECD, 2014). According to the latest data available (OCyT, 2013), R&D expenditure in 2012 reached 0.17% of GDP, recording a slight decline from the previous year, and confirming a trend that has remained virtually unchanged since 2007. In broader terms, spending on STI activities represented 0.45% of GDP, distributed by activity as follows: 38.4% on R&D; 30.6% on innovation activities; 15.2% on scientific and technological services; 9.3% on support to scientific and technological education; and 6.5% on administrative and support costs. The lag is equally significant in terms of scientific output (publications and patents) or higher education (especially in terms of postgraduate and doctorate degrees). Moreover, companies contribute less than a third of overall R&D expenditure, a very low figure by international standards that highlights the limited innovative capabilities
of most Colombian companies, beyond a reduced group of large multilatinas, which have accelerated their international expansion in recent years and have significantly stepped up their investment in innovation.

As is also common in other countries, R&D activities in Colombia are highly concentrated in certain regions and in a few universities, companies and public research groups. Specifically, three of the 32 departments that make up the country account for 76% of total expenditure on R&D (OCyT, 2013). The department of Antioquia represents 27% of the national total, only behind Bogota (41%), and within Antioquia virtually all R&D activity is concentrated in Medellin, where the leading universities and companies of the region are based. In terms of intensity, in recent years spending on R&D in Antioquia stood at 0.37% of GDP, more than twice the national average and also above the 0.31% of Bogota.

Located in the northwest of Colombia, Medellin has 3.7 million inhabitants in its metropolitan area, which makes it the second most populous city after Bogota. In economic terms, Medellin accounts for about 10% of Colombia's gross domestic product (GDP). Historically, the city has always been an important industrial centre and, after a long period of crisis, in recent years it has regained its entrepreneurial dynamism thanks to increased security and a commitment to education, innovation and internationalisation.

Although Medellin’s scientific and technological system is more advanced than that of the rest of the country, serious limitations persist especially considering the difficulties inherent in achieving sufficient critical mass and the weak external linkages of the system. However, a convergence of circumstances supports the conclusion that this is the right time to redouble the city’s bet on innovation. Such circumstances are the recent urban transformation of the city thanks to crime reduction; its recognition as Innovative City of the Year 2013 by the Wall Street Journal, the Urban Land Institute and Citigroup; the hosting by Medellin of the seventh session of the UN-Habitat's World Urban Forum in 2014; and a strong political and institutional commitment to innovation, where the local, regional and national levels converge.

Innovation policies in Colombia

The National Development Plan 2010-2014 was an important milestone in recognising to a greater extent than previous plans the importance of innovation in Colombia’s development agenda and in setting the ambitious goal of increasing annual investment in R&D to 0.5% of GDP. This would require doubling the current levels of investment and would place the country at investment levels similar to those of countries like Chile or Mexico.

Public agency Colciencias coordinates research and innovation policies in Colombia, subsuming the roles of science ministry, research council and innovation agency (OECD, 2014). Colciencias offers various funding programmes for R&D and has also been paying special attention to the training of doctors, which in recent years has absorbed more than 50% of its budget. Colciencias’ R&D support programmes operate on the basis of rounds of applications addressed primarily to universities, although efforts have been intensified recently to involve companies and encourage university-industry collaboration in R&D activities. Another important player is the Ministry of Information, Technologies and Communications, whose Viva Digital Programme aims to promote a technological leap forward through the widespread use of the internet in order to reduce poverty and create jobs. Moreover, with regard to the promotion of business innovation and entrepreneurship, it is important to highlight the role of public agency Innpulsa, which has gained increasing importance since its inception in 2011.

The greatest political priority given to STI in Colombia must be understood in the context of the structural change experienced by the economy over the last decade, following the country's opening up to external markets and the subsequent reallocation of resources towards sectors with comparative advantages.
based on natural resources. The need to promote a diversification of the economy towards other sectors with higher capacity to develop competitive advantages based on knowledge, innovation and human capital, has favoured the establishment in Colombia - as well as in other countries in the region such as Brazil, Chile and Peru –of a new taxation mechanism based on royalties levied on income from sectors exporting natural resources, which allows regional participation and allocates at least a portion of the funds raised to finance STI activities.

Specifically, in 2011 a new General Royalties System was established in Colombia, which provided for the creation of the Science, Technology and Innovation Fund (FCTI). The new Fund is entitled to 10% of the revenues of the system. It is estimated that this Fund will receive annual revenues averaging USD 500 million, which could significantly boost investment in R&D towards the 0.5% target mentioned above (Cuervo and Lopez, 2013). In December 2012 the first allocation of resources was formalised from the new royalty fund, but there was not an actual increase in national expenditure on R&D as the selected projects were not implemented that year. Therefore, publication of STI indicators for the year 2013, in late 2014, will have to be awaited in order to assess the magnitude of the expected jump.

Since it is the regional governments that receive the resources and prioritise the projects to be financed, the royalties system has encouraged decentralisation and favoured the development of regional innovation strategies. Nevertheless, the most backward regions lack sufficient capacity to articulate eligible projects and therefore should substantially increase their capacity to absorb resources. Moreover, the allocation of royalty-derived funds to STI activities faces the difficult challenge of combining two strategies: the first oriented to national strategic areas, which includes performance and scientific excellence criteria; and the second focused on the financing of regional needs and the reduction of cross-regional gaps (Correa, 2012).

The recent review of national innovation policies conducted by the OECD highlights that in the last decade Colombia intensified its efforts in the fields of education and innovation (OECD, 2014). But although the framework conditions for innovation have greatly improved, there is still room for progress and, in this connection, the report presents a series of recommendations that are summarised in Box 1.
Box 1. OECD Recommendations for the national innovation system

Put business at the heart of the innovation system

- Policy has thus far, emphasised support for science and research-driven enterprises, and university-industry cooperation. Important as this is, the potential for innovation cannot be limited to such firms.

- Support from public authorities is of the essence to stimulate innovation across the business sector. Such support should be aimed at developing in-house innovation capabilities within enterprises, notably through investment in human resources.

- Investment in human resources is key for innovation.

- In addition to a focus on doctoral graduates and other high-level skills, more attention should be devoted to professional technical degrees in areas such as design, logistics and management.

- Policy should encourage mobility between firms and public research organisations, facilitate student placements in industry, and foster increased business investment in human resources.

Strengthen the role of universities and public research institutes

- This involves capacity-building, including doctoral training for faculty, creating and funding “centres of excellence” to build critical mass in research and teaching, and encouraging universities to develop their own strategies.

- Policies should nurture durable links between universities and industry through information platforms by giving priority to collaborative projects and by funding longer term “competence centres” that bring industry and academia together to work in areas of mutual interest.

- The government should also consider regulatory and other types of barriers to university-industry collaboration and to the creation of spin-offs, in order to bring down such barriers through policy intervention.

- The public research institute sector must be modernised.

Adapt governance and the policy mix

- In the context of the new royalties system, the capabilities of sub-national authorities must be strengthened so that they can define and implement suitable projects whilst insuring coherence at national level.

- To maintain the coherence of the system, funding from royalties should not crowd out existing sources of funding for R&D and innovation.

- Effective innovation policy will require better coordination across different government departments and between the central government and the regions. This will also contribute to addressing horizontal challenges (such as environmental issues) affecting various ministries and sections of society.

Innovation policy in Medellin

During the last two decades, Medellin has undergone a deep economic, social and cultural transformation that still persists. The city has gone from being known internationally for its high crime rates to being considered a successful example of regeneration and urban development based on a commitment to education, culture and innovation.

Progressively, the development agendas of the city and the department have been moving more clearly towards business innovation as a lever of competitiveness and economic growth, and the institutional basis for efficiently promoting this agenda has been built. Already in the mid-1970s, the ProAntioquia Foundation was created by the private sector as a space for reflection on policies aimed at stimulating business competitiveness, innovation, entrepreneurship, education and social development.

In the 1990s the Centre for Science and Technology of Antioquia (CTA) was created as a public-private entity that is still running and has played an important role in the design and implementation of public strategies in the realm of science, technology, innovation and education. In that period, a team led by Harvard Professor Michael Porter prepared the *Monitor Medellin* report (1994), with the aim of evaluating the city’s potential. This endeavour gave rise to the cluster strategy that has remained in effect until today, albeit with changes through its evolution, under the coordination of the Chamber of Commerce of Medellin.

Other achievements include the strengthening of inter-institutional relationships and the existence of an earnest dialogue between all the actors that make up the regional innovation system: universities, public research institutes, public agencies, and other government bodies and business associations. The contribution of the University-Government-Industry Committee (CUEE) has been decisive. CUEE is a regional alliance of universities, research groups, firms in the productive sector and government entities devoted to generating and promoting applied research projects aiming to meet the technological needs of the region’s industries. In 2007, CUEE created the Tecnova Corporation in order to energise corporate research activity and meet the demand for innovation through its partner universities. Also worth noting is the systematic promotion of an entrepreneurial culture and the support to the formation and development of new firms, which since the mid-2000s has become one of the strategic priorities of Medellin City Council (Kantis et al., 2012).

Another important step was taken more recently towards the development of the local innovation system with the creation, in 2009, of Ruta N, the new innovation agency of Medellin City Council (see Box 2). Ruta N is responsible for the implementation of Medellin's Strategic STI Plan 2011-2021, whose overall objective is to *promote and coordinate policies to support research and scientific, technological and innovative development in Medellin, with a view towards the identification and exploitation of new knowledge-based businesses* (Pineda and Scheel, 2011).
Box 2. Ruta N as a catalyst for innovation in Medellin

Since its inception in 2009, Ruta N has deployed a wide range of programmes to articulate the local innovation system, and has become a model of success both for Colombia and for Latin America in general. Created by Medellin City Council and public enterprises UNE and EPM, Ruta N focuses on promoting the development of innovative technology-based businesses that boost the competitiveness of the city, revitalise its economy, strengthen strategic clusters and provide better jobs for the citizens of Medellin. The mission of Ruta N is to execute Medellin's STI Strategic Plan and its structure consists of three directorates:

1. The Directorate for Innovation Platforms, responsible for developing and enhancing the conditions in the Regional Innovation System so that knowledge-based businesses can be born. Its target audiences are the universities and other interface entities such as business incubators, technology development centres and knowledge brokers.

2. The Directorate for Knowledge-based Business, in charge of facilitating knowledge-based business activities in both new and existing firms. Its objective is to encourage the generation of high-value business transactions both for the city and its companies, building on the assumption that the development of science, technology and innovation requires an ecosystem that provides enabling capabilities and conditions. Such an ecosystem can only be possible if actors in the different sectors are strong and in possession of the appropriate knowledge and tools.

3. The Directorate for Innovation Culture, responsible for promoting social appropriation of science, technology and innovation in the city of Medellin, encouraging social inclusion and sustainability.

Finally, one of Ruta N's most ambitious projects is the implementation of the so-called Medellinnovation district, a new technological district in the north of the city, adjacent to the University of Antioquia, which is intended to act as a magnet for companies, institutions and entrepreneurs in the field of STI.

Source: Ruta N website http://Rutanmedellin.org

The strategic vision of Medellin's STI Plan is to consolidate the city as Latin America's innovation capital given its highly innovative knowledge-based economy, the presence of world-class universities, and by reaching investments in STI of around 5% of local GDP. Overall, the Plan is characterised by the selection of three priority clusters (health, energy and ICT) and an agenda that is clearly focused on the immediate needs of the market. The Plan is structured around four strategic "vectors" intended to increase the participation of the business sector in the global STI effort:

- Definition of strategies, policies and programmes for the creation and accelerated development of technology-based companies in Medellin and its region, and identification of emerging knowledge-based businesses generating high value;

- Initiatives aimed at providing direct support to Medellin’s technology sector;

- Strengthening of Medellin's technology-driven clusters; and

- Promotion of inter-firm cooperation and strategic alliances, with a view to internationalising technology-driven clusters.

The STI Plan includes an extensive battery of specific objectives, measures and policy instruments, still in a development phase, which will require prioritisation (Pineda and Scheel, 2011). Nowadays, the main lines of action of Ruta N under the STI Plan framework are:
• Annual call for projects within the STI Plan: the goal is to support innovation-oriented science and technology projects that have a global market vision and, where possible, are aligned with one or more of the three priority clusters (health, energy and ICT).

• Royalties: local applicants will receive support and assistance when submitting and implementing projects under the national STI fund.

• Science, Technology and Innovation Observatory: using technological surveillance and competitive intelligence tools, an observatory will be established to identify opportunities in areas such as innovation, technological pathways, trends, best practices, and identification of potential R&D partners. The Observatory will analyse the network of actors involved in each of the areas and detect their concentration, alignment and anchorage; search for gaps and opportunities for innovation; examine indicators for innovation, R&D, collaboration, results; etc.

• Structuring international networks: missions to strategic countries are envisaged involving the main actors of specific innovation projects carried out within the framework of Medellin’s innovation system to foster the generation of joint research projects between local and international researchers, as well as to access international funding and technological capabilities.

• Regional Innovation Initiatives: RIIs are communities where universities, companies and government come together to generate strategies leading to innovation projects on the key enabling technologies required by different industries. For 2014 the following nine RIIs have been constituted: nanotechnology, photonics, advanced manufacturing, mass production of pharmaceuticals and biotechnology, innovation in the services sector, electronic devices, scientific computing, clinical metadata repositories, and sustainable construction.

• Virtual platforms to promote innovation: two such platforms have been developed so far: 1) Brainbook, Medellin’s virtual STI network where different actors of the local innovation system come together with the aim of promoting collaboration and articulation in the system. 2) SUNN 4i, an acceleration network for open innovation, which aims to link the supply and demand for innovation in Medellin and Colombia with the rest of the world to encourage the generation of new innovation-driven businesses.

• Innovation indicators: the goal is to collect key indicators to measure the impact of innovation on the economic development of the city.

• Public policies: new policies must be developed to enhance investment in STI and encourage businesses in the city to develop innovative activities.

To implement the STI Plan the main source of funding is provided by public company EPM\(^3\), which since 2012 has been required to allocate 7% of its annual profits to Ruta N’s budget, which—under current conditions—amounts to approximately USD 30 million a year. This adds to the new funds from the national royalties system, as well as to other specific contributions by the City Council.

Towards a new innovation policy agenda for Medellin

Taking into account the remarkable progress made in recent times and the strong political resolve and ambition of the local institutions, the regional innovation system is expected to take a quantitative and

\(^3\)Empresas Públicas de Medellín (EPM) operates in the sectors of energy, water and telecommunications, and is one of the largest Colombian companies and has a significant presence in Latin America.
qualitative leap in the coming years. The commitment to innovation of the National Government and the implementation of the new royalties system, which will substantially increase the funds available in the next years, will also play an important role.

Throughout this Review, taking into account the characteristics of Medellin’s innovation system, reference will be made to a set of strategic priorities that are essential for success. These refer to the following four cross-cutting goals related to the different components of the innovation system. All of them will be discussed in detail in the different chapters of this Review.

- **Multilevel governance.** Any strategy aimed at boosting innovation in Medellin should be consistent with both departmental and national policy. Therefore, although the diagnosis and policy recommendations presented in this document are primarily related to Medellin, the discussion must necessarily be framed in the context of the science and innovation policy of Colombia as a whole. In recent years, the degree of regional autonomy in the field of science and innovation policy has increased substantially in the country, partly as a result of the STI fund created by the new royalties system. Therefore, efficient new mechanisms will have to be created to improve vertical coordination between the National Government, the departments and the municipalities. In addition to this necessary vertical coordination, multilevel governance also refers to horizontal coordination among ministries and public agencies, given that innovation directly affects all policy areas.

- **Smart specialisation.** The smart specialisation strategy (OECD, 2013) involves complementing the existing model used to select priority industrial clusters with an approach focused on identifying global market opportunities, seeking a specialisation in high added-value activities or functions, rather than industries, and incorporating a greater emphasis on identifying enabling technologies relevant to various industries simultaneously. In essence, smart specialisation involves concentrating the scarce human and financial resources available for science, technology and innovation in a few priority areas clearly identified on the basis of regional strengths and comparative advantages.

- **Social innovation.** The aim of public policy should not be innovation *per se*, but its application to improve the lives of people and society in general (OECD, 2010). Social innovation strategies try to link the processes of technological innovation with the fulfilment of social needs, such as environmental protection, social housing and the related infrastructure, and increased agricultural productivity. In Medellin, given the prevalence of poverty, inequality and the informal economy, new approaches are needed to better link technological progress with other social objectives so that the results of R&D are more inclusive. *Inclusive innovation* is understood as a kind of innovation that offers new opportunities and economic benefits to all citizens, contributing to the reduction of social inequalities (Paunov, 2013).

- **Internationalisation.** Innovation is not a phenomenon restricted to national boundaries. Instead, it is produced and disseminated globally. If Medellin aspires to become internationally recognised for its innovative capacity, it should improve its position in global innovation networks (OECD, 2008) through international collaboration in science and technology, and through the attraction of companies, institutions, funds and human capital.
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CHAPTER 2

HUMAN CAPITAL: STRATEGIC ENABLER FOR THE LOCAL STI SYSTEM

Human capital is a central challenge for any territory - national, regional or local - aspiring to establish and consolidate a successful local innovation system to promote development.

Innovation depends on the ability of people to generate and apply knowledge and ideas in the workplace and in society in general. The OECD member countries have recognised, especially in recent decades, the need to develop people's skills through life-long education and training. Thus, as countries strive to find new sources of growth to ensure a strong and sustainable future, they also seek to understand the types of skills needed for innovation and the best ways to develop them (OECD, 2011a).

A discussion on the issue of human capital, its creation, development, attraction and retention, requires an understanding of how such capital interacts with various circumstances and conditions as well as the factors needed to establish and maintain a science, technology and innovation (STI) system in each territorial context, each with its specificities and peculiarities.

Both the national and international literature, as well as the recently applied practical guidance programmes, have discussed some of the key concepts in this field.

No rigorous or widely-accepted definition exists for the terms capabilities and skills. In many cases, they are taken to refer to the variable combination of competencies resulting from a set of educational, training and practical experiences. In any event, wide variability exists across different countries, cultures and contexts (school, enterprise, society) as to how the concept is to be defined (Toner, 2011, EC Innovation Union Scoreboard, 2014).

The concept of human capital is, in turn, closely linked to the concept of skills. According to the OECD human capital is the knowledge, skills, competencies and attributes embodied in individuals that facilitate the creation of personal, social and economic well-being (OECD, 2001: 18).

The primary focus of this chapter is to analyse the important role played by human capital in the dynamics of innovation, a key development factor for Medellin on which several local institutions have strived to converge in the last few years. Also, to identify the future actions needed to strengthen the skills and capabilities of individuals is a prerequisite to understand the current contextual conditions that prevail in Medellin and Antioquia.

The literature identifies several methods (or actions) through which human capital can stimulate innovation (Toner, 2011):

- Generating new knowledge;
- Facilitating the adoption and adaptation of existing ideas;
- Enabling innovation through the enhancement of learning skills;
- Complementing other inputs intended to stimulate innovation; and
- Generating externalities that promote the circulation of new ideas and the development of intellectual and practical cooperation activities, complementing the contribution to growth made by social capital.

Moreover great emphasis has been laid on the crucial role played by skills and capabilities across the different STI-based development strategies and, even more evidently, with respect to local policies aimed at systemic innovation. Human capital in this context plays a multifunctional role:

- To create favourable conditions for attracting potential investors wishing to establish companies or R&D, production or services-based units in innovative high value-added sectors linked to the knowledge economy;
- To establish a context that is, through a multiplier effect, conducive to the attraction of researchers, and talent in general interested in working in STI-related sectors in a dynamic environment (this factor will have to be combined with other local attractions);
- To provide opportunities for exchanges, growth and retention of local talent; and
- To encourage the development of a dynamic context that may create a more virtuous local landscape. Active local environments commonly result in the generation of mutually reinforcing processes determined by the human capital factor.

Considering the overall structure of this Review and the themes discussed in each chapter, it is clear that boosting the quality of jobs, promoting the recognition of talent and developing human capital play a central role and bear a close relationship with the cross-cutting themes discussed in the final section of Chapter 1 (multilevel governance, smart specialisation, social innovation and internationalisation), as shall be seen in what follows.

Generally speaking, a prerequisite that must be met before setting about developing policies on skills, capabilities and talents is that representatives from the quadruple helix, an extension of the triple helix concept developed by Etzkowitz and Leydesdorff (2000), should be able to interact efficiently and effectively with each other. For this to be possible, these stakeholders (academia, government, business and civil society) must share the same language, sensitivity and knowledge. However, in most cases at the international level, these actors do not spontaneously or automatically share a common vision, nor really understand the different perspectives, needs and attitudes regarding STI. Although they are called on to establish synergies, misunderstandings are common and constitute a major cause of weaknesses and inefficiencies in the operation of the local innovation system.

This leads to the need to consider measures, actions and interventions, primarily in the area of education - in the broadest sense of the term - aimed at establishing and maintaining positive interactions between representatives of the quadruple helix. To facilitate this synergistic approach, facilitators and knowledge brokerage agencies, intermediaries and concertation bodies should play a decisive role, bringing together different views and perspectives seeking a common understanding and building a shared strategic agenda. It is also important to build and maintain, for each strand of the helix, specific competences and skills, through complementary and converging paths, which help stakeholders from all sectors achieve higher levels of mutual understanding and joint action. Interventions should also take into account the different roles and responsibilities of each actor when developing a local strategy for STI.
Key policy issues

The sections below discuss some components of Medellin’s innovation and human capital management system from the regional and national perspectives. This description is not aimed at being exhaustive, as the reader can refer to a number of diagnoses and analyses of the system published in recent years. The purpose of this description is limited to providing enough key information to explain and contextualise the specific recommendations concerning human capital formulated within the framework of the city's and the region's innovation strategy.

Prominent elements at national level

The Prosperity for All National Development Plan (PND) 2010-2014 is the framework that outlines the various lines of action to be followed for the development of the country. Among them stands out the axis of Sustainable Growth and Competitiveness, for which three pillars are defined 1) innovation; 2) competitiveness and productivity policies; and 3) promotion of stimuli for growth and job creation.

The Plan reveals the existence of a considerable gap between Colombia and similar countries as regards the development of science, technology and innovation. Several factors contribute to this gap, the most significant of which include the lack of highly skilled human capital in areas designated as innovation areas, and the scarcity of mechanisms to lure back to the country Colombians living abroad with the potential to contribute their capabilities, knowledge and experiences to the development of science, technology and innovation.

The strategic policies developed to promote innovation as a vehicle for prosperity include upgrading the quality of entrepreneurship and innovation training programmes; implementing vocational training, graduate, postgraduate, and PhD programmes and scholarships through the Bicentennial Generation Programme, ICETEX, SENA, the Young Researchers and Innovators programme, and apprenticeship contracts, among others.

To increase competitiveness and productivity in the country, the PND indicates that skills development should be directed to:

- Consolidating the development of skills in basic and secondary education; strengthening the system used to evaluate students and professors; further developing basic and civic skills in children, teenagers and professors; and strengthening the use and assimilation of ICTs and English-language skills.
- Implementing an emergency skills training plan targeted at the priority areas and other focus areas defined in the Productive Transformation Programme.
- Consolidating the human resources management strategy by: (i) creating the National Skills Certification System, (ii) designing and implementing a National Qualifications Framework (iii) establishing mechanisms to promote dialogue between the productive and training sectors; and (iv) providing more in-depth information related to labour supply and demand.

The most outstanding element of the National Decennial Education Plan (PNDE) 2006-2016, which contains the set of proposals, actions and objectives that express the will of the country with respect to education, is the wide-ranging goal of investing in science, technology and entrepreneurship, thereby
promoting a knowledge culture. The educational goals in the departmental and municipal development plans for 2012-2015 must be articulated with those in the National Decennial Education Plan 2006-2016.\(^4\)

In recent years, Colciencias, Colombia’s Government Department of Science, Technology and Innovation, has made available in excess of 50% of its budget to produce more doctoral graduates, mainly to work in the field of higher education, but also with the aim of increasing the number of PhDs employed in industry, where they are still extremely rare.\(^5\)

The OECD Review of Colombia’s Innovation Policy (OECD, 2014) underscores the central role played by Colciencias in the national innovation system. It also notes that Colciencias must act as an innovation agency to redouble its support for the development of innovation capabilities in the business sector, and that it should pay attention to the development of mid-level professional skills and not just to the education of PhDs (OECD, 2014).

**Outstanding elements at the local level**

A shift has been observed in Medellin in recent years whereby academic institutions, local and departmental governments favourable to innovation. The increasing emphasis in the international debate on new trends in the field of development, such as the knowledge society, the challenges of systemic innovation, etc., together with the availability of resources, prompted the local government to address efforts towards establishing Ruta N in 2010 and formulating an **STI Strategic Plan** for 2011-2021 (see Chapter 1 for details), whose implementation is precisely the responsibility of Ruta N.

The Plan is the result of extensive work to raise awareness at the local level about the challenges inherent in national and global competition. The Plan seeks to provide rationality and coherence against a background of countless activities and initiatives implemented in the previous two decades with a view to promoting a culture of innovation at the local level.

In this dynamic and evolving context the human capital factor, the development of skills and capabilities, and their maintenance over time, including all stakeholders, are obviously of central importance. It is worth noting that as a result of the “ecosystem perspective” taken by local actors with respect to innovation, and in accordance with current international trends, the analysis cannot be limited to the **hard** skills needed to innovate (technology, technology transfer techniques, enhancing workforce innovation and technology transfer capabilities, etc.), but should also include the **soft** skills (ability to interact in multidisciplinary and multicultural contexts, network building, participation in open innovation schemes, etc.). Attention should also be paid to the governance of the STI strategy in accordance with a multilevel logic, in line with the recommendations of the OECD Review mentioned above.

The STI Plan establishes the following goals with respect to human capital:

- Encourage training, specialisation and upgrading of human resources, establishing engineering and science master’s degrees and doctoral programmes related to the priority production chains.
- Promote the dissemination of information about science, technology, human resources, business organisation and financial services.

\(^4\) Significantly, one of the objectives of the PND 2006 is: to increase investment at all levels of government so as to ensure a wide range of sustainable, equitable, high quality and efficient physical and administrative resources to improve and modernise the infrastructure and technological equipment of educational establishments and higher education institutions. The aim is to strengthen science, technology, research, innovation and entrepreneurship at all levels and types of education, thus creating a knowledge culture.

\(^5\) See also Chapters 1 and 3 for details on the role of Colciencias.
Joint Vision, institutions and local networks

Colombia's strategic guidance documents at all levels of government (the PND at national level, as well as those at the level of Antioquia and Medellin) contain sections that emphasise the importance of acting on human capital where they define the most important elements of innovation policy. The emphasis on human capital is also present in the strategies aimed at boosting competitiveness and developing the business sector.

An obvious alignment towards the key issue of capacity and skills building is observed. The result of this consistent view is that several institutions and public funding sources have oriented their efforts toward supporting programmes, projects and initiatives for promoting human capital as part of innovation processes.

In fact, this is not an "original" concept, as both the specialised literature and other international experiences confirm the essential role of strengthening human capital as a precondition to taking action for development (OECD 2011b; Toner, 2011).

The strategic challenge, considering the peculiarities of the local context of Medellin and Antioquia, is related to:

- The definition of a specific long-term vision, shared between the relevant actors, on the human capital factor within which actions aimed at developing and strengthening skills and capabilities should be framed;
- The development of the most efficient and effective ways to act given the context; and
- The "structural" strengthening of the capacity to govern these processes, strengthening inter-agency coordination according to a multilevel governance approach, as this is one of the strategic cross-cutting goals that have been proposed in this report for Medellin's new innovation policy agenda.

Furthermore, all local STI actors in Medellin and Antioquia are aware that addressing the issue of human capital for local innovation requires the joint effort and a converging strategic vision that encompasses different forms, methods and tools; and that they must operate in a coordinated manner in order to achieve sustainable tangible results in the long-term.

These results consist in strengthening all those skills and capabilities needed by the local STI systems, as well as their effective and gradual integration into entities (companies, government agencies, technology centres, etc.) where the staff is expected to be equipped with specific innovation skills.

One of the main strategic priorities to promote an efficient innovation system will be to make institutional efforts towards training human resources in strategic areas harnessing the potential of all primary, secondary and higher level educational institutions in Medellin and the Antioquia region.

In this connection, political decision makers assign a central role to Ruta N Corporation as a facilitator and a catalyst for the system. The Corporation was precisely established with a view to creating a "local innovation ecosystem" targeted to promote a culture of innovation, knowledge management, network management, market access, access to capital and business innovation.

As regards the development of human capital and talent for innovation, Ruta N's strategic approach emphasises the need to strengthen the capabilities of the innovation system and its actors. This approach
has resulted in initiatives aimed at fostering positive interactions with vocational training and higher education institutions.

A case in point is the Innova campus programme, launched in November 2013, with “the aim to strengthen the innovative capacity of higher education institutions in the region through expert support for innovation in the curriculum, thereby promoting the development of new skills and enhancing the standards of institutions, students and graduates”. A call for applications was issued to select ten pilot programmes involving the “curricular changes in vocational higher education programmes that make an innovative contribution to the quality and relevance of the academic offer of higher education institutions in the city.”

Before the establishment of Ruta N, Antioquia already provided several examples of inter-institutional coordination and cooperation in the field of higher education aimed at creating synergies that could benefit the local system as a whole. One of these examples is the Grupo G8 Rectores created 10 years ago as an informal forum for dialogue between 8 major universities in Medellin, intended to exploit synergies between academic institutions and strengthen the teaching, research and academic extension activities of these entities.

Another case, which dates to as recently as 2013, is the Sapiencia Alliance, a partnership between the Metropolitan Technological Institute, the Colegio Mayor de Medellin and the Pascual Bravo University Institute, established to integrate the efforts by local technological universities to build synergies around infrastructures in the areas of training, dissemination, university-industry collaboration, and technology management and transfer processes.

Finally the University-Government-Industry Committee, established as a partnership between representatives of the three components of the triple helix, also plays a decisive role (for details see Box 3).

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6 Further information at: http://rutanmedellin.org/index.php/es/actualidad/noticias/item/innovacampus-la-apuesta-de-ruta-n-por-la-transformacion-curricular-20140220
Box 3. The Antioquia section of the University-Government-Industry Committee (CUEE)

The Antioquia Section of the University-Government-Industry Committee, is a strategic partnership that facilitates the pooling of resolve and knowledge of entrepreneurs, university administrators, unions and local and regional governments to draw up joint research, development and innovation (R&D&I) agendas aimed at boosting corporate productivity and competitiveness, through dialogue. Established in 2003, the University of Antioquia's Technology Management Programme is responsible for the Committee's Technical Secretariat. Its mission is to create spaces for dialogue and consultation, and promote entrepreneurship, innovation and partnerships conducive to Antioquia’s economic and social progress. The Committee is made up of 11 influential higher education institutions in the region, 21 companies, seven technological development centres, Andi, Acopi and Comfenalco, as well as the Ministries of Education of Antioquia and Medellin, among others. The eleven higher education institutions are:

- National University (Medellin campus)
- Medellin University
- Universidad Pontificia Bolivariana
- Lasallista University Corporation
- CES University
- University of Antioquia
- EAFIT University
- Antioquia Engineering School
- Politécnico Jaime Isaza Cadavid
- Colegio Mayor de Antioquia
- Pascual Bravo University Institute
- Metropolitan Technological Institute

During its seven years of work, the Committee has undertaken numerous investigations that made a great impact on Antioquia's business sector such as Investigación y Documentación de la Experiencia Universidad-Empresa-Estado de Antioquia, a testimonial documentary that proved extremely useful to both Colombian and foreign universities, businesses and governmental entities, and has become a model for other committees in the Country that also have the goal to bring these actors together on collaborative initiatives.


The experience of other countries has also highlighted the value of the human capital already "installed" in the corporate sector. Indeed, successful territorial innovation systems do not only result from cutting-edge STI-intensive companies, but may also be achieved by upgrading the local ecosystem of existing businesses as a whole. This perspective implies the need to treat human capital in a differentiated way, adapting it to specific company needs, different business subsystems and the characteristics of individual firms.

There is no doubt that strengthening, qualifying and energising human capital is a decisive prerequisite that requires a continuous effort under a medium- and long-term perspective. For these conditions to be met, Medellin will require:

- Broadening the base of companies that develop innovative initiatives;
• Achieving efficient synergies between universities, STI centres, and the different levels of government in Medellin and Antioquia; and

• Establishing a platform whose members share knowledge and possess the same sensitivity towards the opportunities and challenges inherent in embracing innovation as a system.

**The education and training system**

Education spending in Colombia as a percentage of GDP in the period 2007-2011, went from 7.19% to 7.65%. More specifically, spending on higher education increased from 1.84% to 1.96%. Moreover, total public expenditure on education as a proportion of GDP increased from 4.28% to 4.75%; the figure rose from 0.86% to 0.98% in tertiary education. These figures compared to those of OECD member countries, where total spending on education averaged 5.9% and spending on higher education 1.5% of GDP in 2008) and those of Latin American countries, where total spending on education averaged 5.3% and spending on higher education 1.3% in 2008 show that Colombia devotes a significant percentage of its resources to education that is above the OECD and Latin American averages.

**Box 4. The higher education system in Colombia**

Higher education in Colombia is available at two levels: **undergraduate and graduate**

The **undergraduate** level has, in turn, three levels of training:

- Vocational Training Level (technical programmes);
- Technological Level (technological programmes);
- Professional Level (university programmes).

**Postgraduate education** includes the following levels:

- Specialisations (Vocational Technical Specialisation, Technology Specialisation and Professional Specialisation);
- Master's degrees;
- Doctoral degrees.


Furthermore, in 2010 13% of all students enrolling in educational programmes in Colombia did so in Antioquia, in line with the percentage of the country's population living in the region. Within the department, Medellin accounted for 53% of students in elementary and secondary education and for 94% of those in higher education.

This is because most higher education institutions of the department are in Medellin and the Metropolitan Area of the Aburrá Valley, whereas only a limited number of universities operate in other subregions of Antioquia. It should also be pointed out that the undergraduate level represents in Colombia as a whole 94% of all higher education enrolments, whereas in 2010 Antioquia recorded a gross tertiary
education enrolment rate of 40.9%, below the rate for Bogota (73.7%), Quindio (50.4%), Santander (48%) and Norte de Santander (42.8%).

Antioquia has a diversified higher education landscape: there are 41 higher education institutions (HEIs), 1 vocational training institute, 10 technological institutes, 23 university institutes and 7 universities. Eight out of the 41 HEIs are public and 33 are private. In addition to the main campuses, the sector has additional sectional branch campuses.

As a whole, Antioquia’s higher education sector plays an important role in the formation of advanced human capital, with over 21,000 highly skilled professionals graduating every year from higher education institutions, most of whom are still working in the region. A high proportion of these graduates look for and find jobs in the region. Of all the different departments in Colombia, Antioquia has the highest proportion of locally trained graduates (85.7%). (Brunner et al, 2012)

However, nationally, the current flows of human resources from higher education do not seem sufficient to allow the country's innovation system to quickly narrow the gap with international competitors. Indeed, despite the economic growth recorded during the last decade, limitations in human resources may constrain the innovation system’s ability to effectively absorb the expansion of STI funding expected to follow from fundamental recent changes in the political and institutional context of the country's innovation system and the strong commitment of the Colombian government (OECD, 2013).

While Antioquia has made great strides in education and has in general shown a better performance than the Colombia average in terms of the key educational indicators, the department still has a long way to go to attain OECD averages.7

SENA, the Colombia’s Vocational Training Agency, a long-established and nationally prominent organisation that is funded by a payroll levy, plays a major role in training workers without higher education. It also provides higher education to about 3.8% of those aged 15 to 24, even though its main task is to develop vocational skills. In 2013, it provided training to 7.6 million people through its 116 training centres. At the level of the department of Antioquia, SENA has 15 centres providing training in the fields of fish farming, foodstuffs, agro-biotechnology, natural resources, footwear, leather goods, fashion design, multimedia production, furniture design, health services, construction, mining, agribusiness, and tourist services, among others. In 2013, SENA trained 789,000 persons in the department.

The OECD Review of Colombia’s Innovation Policy (OECD, 2014) emphasises that the balance between technical education and higher education is problematic in Colombia, as well as in much of Latin America, often with 70% of a cohort in higher education and 30% in technical education. The ratio in OECD countries is typically the opposite. This problem has been visually represented in literature through the image of the inverted pyramid (Bitran et al., 2011). Given Colombian companies’ relative lack of mid-level technical occupations, this seems to explain to some extent repeated industry comments about a skills shortage and lack of experience in middle-level functions.

Local education stakeholders recognise the inverted pyramid as a significant problem in Medellin and Antioquia, derived partly from the limited social and professional recognition enjoyed by staff with technical training. Moreover, the low wages of these workers are generally in keeping with their low social consideration. It is also necessary to promote a change in the attitudes of entrepreneurs and MSMEs, encouraging them to actively participate in the technical training of their employees and to develop a more

7 In Antioquia, 35.5% of students reach tertiary education, but overall educational attainment remains low, with significant disparities between rural and urban areas. At the same time, the average number of years of formal education for Antioquians is 8.74. However, this figure is 6.33 for rural areas. Similarly, the illiteracy rate in Antioquia is 5.1%, but in rural areas it is 10.6% (Brunner et al, 2012).
open attitude towards apprenticeships, participating in the programmes sponsored by SENA, which have been adapted from the German experience of "dual vocational education and training" (Euler, 2013).

Medellin’s secondary school and higher education system has an "installed capacity" of high value, an indispensable premise to effectively upgrade human capital skills in accordance with the needs of the local STI system, which is currently being structured and consolidated.

Local institutions and companies can benefit from the resources made available at national, regional and local level, in accordance with the goal of strengthening human capital, which is considered a foremost priority by the various strategic plans (development goals in general and STI promotion goals in particular, discussed in the previous section of this chapter). Notable examples of funding providers playing a strategic role in supporting STI-driven human capital include Colciencias and SENA at national level and Ruta N at local level.

The local enterprise system

From the point of view of the broader regional territorial system and not only of the local urban context, at the end of 2011 Antioquia had 132,999 businesses registered in the five chambers of commerce of the department; 71.5% of the firms were located in Medellin and the Aburrá Valley. By 2012 the Chamber of Commerce of Medellin reported 90,320 renewed and registered companies (Vargas et al., 2013).

As mentioned in Chapter 4, Colombia is far behind the rest of Latin America in terms of investments in R&D, particularly in the private sector. In Antioquia, universities are at the forefront of STI activities, providing 47% of investment, while private companies take second place with a contribution of 26%. In addition, participation of Antioquian companies in R&D investments fell from 44% in 2000 to 26% in 2010, while involvement of higher education institutions has remained relatively constant. In Colombia as a whole, the decline in the participation of private businesses in R&D was less abrupt, going from 47.4% in 2000 to 34.6% in 2012. In spite of this decrease, still the corporate sector keeps leading the investments in STI activities (source OCyT, 2013).

The need for enterprises in Medellin and Antioquia to enhance the development of human capital in the field of STI is a clear priority if the current trends are to be reversed in the medium to long-term. Furthermore, reflections should not just involve cutting-edge knowledge-intensive companies, which are obviously the key strategic target, but also the business system as a whole. The goal of becoming a leader in innovation at the end of the decade requires the ability to establish an environment capable of generating the dynamic ecosystems that are so essential to achieve this ambitious goal. It is therefore mandatory to act on every level of the business system, inducing a cultural evolution that involves local economic agents and society at large.

As will be further discussed in Chapter 4, the companies leading the local industrial system in Medellin include some of the largest companies in Colombia, which have STI-programmes and have made major investment in STI. One of the most notable examples is Empresas Públicas de Medellín (EPM) which has injected significant resources into the local innovation system and has pledged to invest 7% of its ordinary profits in STI initiatives relevant to the municipality. In addition, a number of international companies have established themselves in the region. Also, a growing number of international companies have expressed an interest in setting up shop in Medellin through Ruta N's Landing strategy (see Chapter 6).

Generally speaking, the dynamising role of large newly-established knowledge and technology-intensive international companies is beyond doubt, no less on account of the STI-related investments they
have made in the local economy. This dynamism could act as a trigger to promote an increasing correspondence between the offer of the local educational system and the growing demand of qualified personnel and talent. In fact, some examples of this have already been observed.

However, as mentioned above, the business system of Medellin and Antioquia as a whole is mainly made up of micro and small companies with very limited or no capacity for innovation, where neither management nor the workforce are able to benefit from technological education nor of an innovative culture.

This has resulted in a widening gap between two virtually watertight sub-systems, whereby small and micro enterprises in the more traditional sectors have lost their competitiveness over the last few decades as a result of the low skill levels of their management and employees. This has prevented them from benefiting from the opportunities that innovation provides and even from establishing a connection with the STI centres already in existence in Medellin. To facilitate the generation of a mutually beneficial system it is necessary to establish a more permeable system that facilitates the positive dissemination of knowledge.

Among other measures, this would necessitate the creation of a mechanism to upgrade the qualifications of human resources in the field innovation, which should encompass not only high or very high-specialisation levels, but also secondary education and vocational training.

In summary, as far as human capital is concerned, the measures adopted should be tailored to the different kinds of companies that make up the local corporate fabric: MSME, large companies, technological start-ups, etc.

It is also essential to understand how each one of the stakeholders in the local ecosystem can create synergies with the others, contributing their individual expertise and making sure that their combined effect is greater than the sum of their individual efforts.

Coordination between the different actors and multilevel governance

Currently Medellin and Antioquia as a whole bear witness to a confluence of different types of institutional designs, initiatives, discourses and visions. This diversity is the result of an over 20-year process during which different national, departmental and local authorities have strived to create a governance environment where multiple public and private decision-makers could coexist. These efforts are clearly reflected in the specific case of the education and talent building sector, where Medellin boasts around 30 public and private higher education institutions and Colciencias has recorded the existence of as many as 738 research groups. For this dynamic reality to be able to really express its true potential, flexible and resilient - yet effective - governance structures must be introduced that are able to increase the efficiency of vertical interconnections between national, regional and local institutional levels, in order to stimulate horizontal articulations.

Achieving such horizontal coordination between various institutions and stakeholders who fulfil different, sometimes complementary and often overlapping, roles in Medellin's STI ecosystem is one of the challenges facing the system. The availability of a wealth of installed capacity versed on various relevant topics is evident. An example of this is the high capacity to generate projects that add to the resources of Colciencias. However, the efforts made thus far at municipal and departmental levels to promote inter-agency coordination (G8, Sapiencia Alliance, CUEE, etc.) have not been significant enough. These can

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For a detailed analysis of these groups, see Chapter 3 section “Medellin’s Universities and research groups”.

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8 For a detailed analysis of these groups, see Chapter 3 section “Medellin’s Universities and research groups”.
indeed be regarded as preliminary experiences, but the inability for the sector to operate as a "system" is still evident.

As a result, there is still insufficient coordination between the different stakeholders. This is particularly evident in the case of training institutions and results in a systemic weakness that hinders the effective expression of their potential, preventing them from generating a true "system" that can exert a significant and durable impact on skills development and talent recognition.

As regards secondary and higher-education institutions - the richest source of skills and talent - the problem is particularly sensitive because creating an innovation ecosystem, the underlying ambition in Medellin's STI Plan, requires the development of an effective network between the different actors playing a role in the development of human capital at a local level. In the medium to long-term, this adaptive and flexible "molecular network”, should become a catalyst for such an ecosystem.

A well-functioning local innovation ecosystem with an effective and recognised governance system is also essential on account of the international projection of Medellin.

Participation in international knowledge networks is now easier than ever and several technology-driven companies and STI institutions in Medellin are already active in this area.

However, openness and an active presence in the global context are a crucial requirement for these stakeholders rather than a simple opportunity, as participation in international networks would stimulate the generation of local skills and talents. In turn, they can act as facilitators and even catalysts in these processes.

Additionally, integration into global networks could also attract to Medellin not only STI-driven investments (for more information see Chapter 6), but also international experts and talent whose knowledge could fertilise the local STI fabric. Such integration could also give rise to contacts with expatriate Colombian talent either promoting their return or at least leveraging contact with them as a way to gain access to the STI centres they belong to.

All of the above can generate systemic effects rather than just offer sporadic or fortuitous opportunities provided that an all-encompassing approach is utilised where every stakeholder is aware of their strengths and weaknesses against global competition and is capable of becoming a competitive player on the international stage. In this regard, the importance of strengthening the human capital available and their individual skills cannot be overstated. A clear, though sometimes underestimated, example of this is the recognition that the acquisition of English-language skills is an important part of training. This was recognised by the Antioquia government in 2008 when the “Antioquia Bilingual Programme” was launched.

**SWOT Analysis**

From diagnosis carried out considering the characteristics of the local Medellin STI system focussing the decisive role that human capital plays in its development and strengthening, Table 1 summarises the relevant strengths, weaknesses, opportunities and threats.
CHAPTER 2: HUMAN CAPITAL: STRATEGIC ENABLER FOR THE LOCAL STI SYSTEM

PROMOTING THE DEVELOPMENT OF LOCAL INNOVATION SYSTEMS: THE CASE OF MEDELLIN, COLOMBIA © OECD 2015

SWOT Analysis

<table>
<thead>
<tr>
<th>Strengths</th>
<th>Opportunities</th>
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<tbody>
<tr>
<td>• Ambitious strategic vision in terms of developing local STI capabilities and a coherent policy. These are important requirements for a local innovation system where human capital and the conditions for capacity-building play a decisive role.</td>
<td>• Inserting the &quot;Medellin system&quot; in the context of globalised STI systems would result in the strengthening of local human capital.</td>
</tr>
<tr>
<td>• Consolidated and renowned education, training and research institutions providing qualified human resources to the STI system.</td>
<td>• Availability of resources: i. to strengthen the supply of STI-based skills, capabilities and talents; ii. to symmetrically boost the demand for skilled employment.</td>
</tr>
<tr>
<td>• Convergent commitment at national, regional and local level to build the skills and capabilities required by Medellin's local innovation system.</td>
<td></td>
</tr>
<tr>
<td>• Presence of highly innovative leading companies that stimulate the local training offer, especially at tertiary and more advanced levels.</td>
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<tr>
<th>Weaknesses</th>
<th>Threats</th>
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<tbody>
<tr>
<td>• Weak coordination across the various local educational institutions and between these and the labour market.</td>
<td>• Prevalence of centrifugal dynamics and disruptive competition between local actors involved in the generation, strengthening and utilisation, of human capital.</td>
</tr>
<tr>
<td>• Multilevel governance fails to support the local innovation system with effective mechanisms.</td>
<td>• Political instability and institutional inconsistencies that favour a short-termist attitude that weakens the major initiatives under way aimed at the structural development, strengthening and consolidation of human capital for the local STI system.</td>
</tr>
<tr>
<td>• Gap between cutting-edge companies (multinationals and multilatinas) and most other firms (MSMEs) in Medellin.</td>
<td></td>
</tr>
<tr>
<td>• Limited mobility of human resources between triple helix actors and weak spillover effect in terms of knowledge sharing.</td>
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On the one hand, Medellin is undoubtedly in a favourable position, having embraced a strategic orientation aligned with the international trend that recognises innovation as a determining factor for competitiveness. On the other hand, the city has access to enough resources - from national, regional and local origin – in order to address the factors responsible for the structural weakness of its training and human capital systems, and generate an impact in the medium and long-term. Action is needed in the following areas:

• Improving the quality of secondary education in order to address the inverted pyramid predicament whereby the amount of postgraduates exceeds that of secondary level professionals and companies cannot meet their demand for technical specialists;

• Strengthening the capacity of educational and training institutions to guide and effectively adapt their training offer (secondary and higher) on the basis of the real demand of businesses and STI institutions; and

• Making sure innovation enablers, whether they are based in firms, specialised agencies or in the government sector, are provided with high quality training and subsequently given access to ongoing training schemes that help them keep abreast of the latest developments in their field.
CHAPTER 2: HUMAN CAPITAL: STRATEGIC ENABLER FOR THE LOCAL STI SYSTEM | 49

Recommendations

The recommendations below should be interpreted as an adaptation to the Medellin’s local STI system of the recommendations for human resources in the STI sector outlined in the OECD Review of Colombia's Innovation Policy (OECD, 2014).

The recommendations proposed for creating attracting, retaining and developing skilled human resources for the STI sector are closely linked to the discussion under the section dealing with R&D investment in Chapter 3 below. Careful reading of those paragraphs provides a fuller picture of the problem as the two issues have obvious mutual implications.

The premise is that the subject matter of this chapter is the intersection of policies aimed at generating skilled human capital and promoting active labour market policies. The recommendations proposed in this section are relevant to both goals.

Generation of skilled human capital

This is the goal targeted by all capacity-building initiatives (particularly higher, university and postgraduate education); life-long improvement of existing skills (training, retraining and skill reorientation, etc.); and strengthening entrepreneurial and management capabilities (orientation and openness to innovation, innovative entrepreneurial networks, etc.).

The recommendations identified for Medellin and Antioquia are directed towards:

- Developing an action plan for human capital that integrates measures and actions geared to upgrading STI-based skills and capabilities under a systemic approach that considers the human capital factor as a complex issue requiring a comprehensive view.
- Establishing a system to coordinate local players on the supply side of education and training, both in the corporate and the government spheres, to facilitate implementation of synergistic actions to address persistent issues facing human capital in the STI sector.
- Developing STI-related skills in human capital working throughout the corporate sector. The development and strengthening of human capital should be based on measures specifically tailored to different companies, sectors, technological levels, propensity to innovation, and size.

Active job placement policies

In the context of labour policies, a number of possible measures should be implemented with a focus on creating opportunities aimed at facilitating the recruitment of qualified personnel by local companies and the organizations devoted to the support of innovation (agencies, public and private STI centres, service and technology transfer units).

"Advanced” job placement requires the adoption of the necessary measures to establish a virtuous link between the supply and demand for qualified personnel (considering several comprehensive measures: apprenticeships, advanced in-company learning systems, the exchange of STI staff between centres, universities, dynamic companies, etc.).

Apart from the elements already mentioned, a series of virtuous demand generation programmes for skilled employment are required, which are an "indirect" by-product of the policies and actions contemplated under other strategies being developed around Medellin’s innovation system (the fact that two chapters in this Review, Chapters 3 and 6, discuss recommendations regarding “internationalisation,"
underscores the need that the various players involved acquire the capabilities required to act efficiently in that respect. Energisation of the local innovation system, through a set of specific actions, stimulates the demand for human capital and for specific knowledge. This demand should be leveraged by implementing first of all relevant training activities and subsequently job placement programmes for the newly trained human capital.

Regarding the needs for new skills that arise in parallel with actions aimed at building and strengthening Medellin’s innovation system, a strategically important caveat should be taken into consideration: generating qualified human resources - especially highly-skilled personnel - requires time and is associated with a lag, sometimes critical, between the time when a specific need is identified for which there is insufficient supply, and the time that it takes to generate this capacity, through targeted training activities.

The identified recommendations are addressed to:

- Generate demand for innovation-oriented human capital. Encourage all companies (not only technology and knowledge-intensive ones, but the local business system as a whole) to consider the recruitment of innovation-oriented human resources as well as continuous training of employers, employees, and of the workforce as a permanent strategic investment priority.

- Improve the connection between the supply and demand of qualified personnel. A set of systemic STI-based actions should be implemented with a view to better identifying companies’ needs of qualified human capital, also considering the unexpressed implicit and potential demand. As the need for innovative corporate capacity increases, this demand will undoubtedly increase and it will be essential to match the supply of qualified personnel to this emerging demand.

The proposed recommendations are developed in greater depth below:

**Develop an action plan for human capital**

To obtain durable and virtuous results in terms of skilled human capital, a strategic medium and long-term perspective must be adopted.

It is then necessary to design and establish an action plan for human capital and innovation-related talent for Medellin that includes educational institutions of all levels, from primary school to university. International experiences indicate that an innovation culture, as well as an entrepreneurial spirit, can be encouraged from the early years of the education cycle. It cannot be forgotten that generation of human capital and talent is a long-term process that requires undertaking a series of actions whose results only show themselves many years down the line.

Considering the specific recommendations regarding human capital in the OECD Review of Colombia's Innovation Policy (OECD, 2014), an action plan is considered a useful measure to define a shared long-term strategy to meet the ambitious goals set for Medellin as an innovation ecosystem. We refer in particular to:

- Improving the performance of technology and research agencies concerning the transfer of technology to enterprises by facilitating the mobility of human capital and the exchange of STI-specialised personnel between universities, technical and vocational education institutions, research institutes and technology innovation agencies (such as technology and knowledge transfer centres, IEBTA, Tecnova, CTA etc.) and businesses.
• Ensuring that the supply of higher technical education is aligned with current and future needs of the local industry, making sure the supply of technical/professional degrees is consistent to business demand, and encouraging enterprises to play a proactive role in developing the STI-savvy personnel they require;

• Developing mechanisms and incentives to encourage firms to invest in medium and high-level innovation capacities as part of the set of actions carried out to raise the level of R&D in the business sector.

This action plan will be one of the four strategic programmes of Medellin’s overall STI Plan. It must also be conceived as an integrated and coherent part of the smart specialisation strategy proposed by this Review as one of the cross-cutting strategic priorities of Medellin’s new innovation policy agenda.  

In addition to the activities already contemplated in Strategic Programme 1 of the STI plan, the Action Plan recommends the consideration of further initiatives particularly relevant to Medellin.

The development of STI-driven human capital and talent and initiatives based on knowledge and the advancement of technology does not solely result from formal and academic education. The most common way to generate innovative solutions, especially in smaller companies, is not through formalised processes but by the gradual accumulation of small continuous improvements, a type of innovation defined as incremental innovation as opposed to radical innovation (Euler, 2013, Davila et al., 2005). The kind of innovation most needed by Antioquia is not based on high technology or on knowledge generated by sophisticated research centres and laboratories, but on incremental improvements in the way products are manufactured and traded by companies of low and medium technological intensity, which still constitute the majority of the local business landscape (Brunner et al., 2012). The Action Plan should not contemplate the two approaches represented in the following table as mutually exclusive, but rather as complementary as they are deeply intertwined.

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9 See Chapter 1 for a conceptual approach to the cross-cutting strategic priorities; and the first recommendation in Chapter 5 for further details on the Smart Specialisation Strategy notion.

10 Strategic Programme 1 of the STI Plan, “Training and upgrading of human resources in science, technology and innovation.” contemplates the following activities: i) training of young researchers, ii) stabilising the number of staff devoted to applied research; iii) providing permanent training programmes for researchers; iv) creating and maintaining workplaces that stimulate human development; v) advancing the transfer of the results of research to the corporate sector in order to shorten the product’s time to market as much as possible; vi) providing permanent contracts to researchers; vii) supporting researchers who develop new products or business models; viii) creating an international research group; ix) purchasing specialised state-of-the-art equipment for research activities; x) permanently evaluating the existing incentive systems aimed at stimulating research.
Incremental and radical Innovation

<table>
<thead>
<tr>
<th>Definition of radical innovation</th>
<th>Definition of incremental innovation</th>
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<tr>
<td>New to the world</td>
<td>New to the firm</td>
</tr>
<tr>
<td>Provides a radical improvement in performance</td>
<td>Provides a gradual improvement in performance</td>
</tr>
<tr>
<td>Requires new skills, capabilities or knowledge</td>
<td>Uses existing skills and processes</td>
</tr>
<tr>
<td>Destroys existing organisational skills</td>
<td>Improves existing organisational competencies</td>
</tr>
<tr>
<td>High risk</td>
<td>Low risk</td>
</tr>
<tr>
<td>Requires a change in the business model</td>
<td>Operates within the existing business model</td>
</tr>
<tr>
<td>Radical innovation provided by sustainable development requires social and systemic change</td>
<td>Perpetuates existing social practices</td>
</tr>
<tr>
<td>Defies status quo rules and therefore leads to the identification of systemic resistance to change</td>
<td>Does not challenge systematic status quo, and may therefore be adopted with little resistance</td>
</tr>
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</table>

Source: Prepared by the authors on the basis of Davila et al., 2005

International “dual vocational training” programmes, consisting of exchanges and apprenticeships between educational institutions and enterprises, provide benefits both in terms of the lessons on innovation learned in the classroom and the more informal innovation-related experiences acquired in the business setting. In this respect, mention should be made of the renowned German Vocational Education and Training (VET) Programme, which together with the Danish VET system is one of the most recognised VET systems in the world. In fact, a few of SENA’s programmes (e.g., Sistema de Gestión del Conocimiento) are inspired by it. In both the German and the Danish VET systems the basic concept is the combination of apprenticeships in a company and vocational education in an educational institution.
Box 5. The dual vocational education and training system in Germany

The German vocational training system, with its combination of classroom and business, theory and practice, learning and working, is recognised worldwide as a basic and highly effective vocational training model.

The dual VET system is a structural part of the German education system and its essential characteristic is cooperation between enterprises on the one hand, and public vocational schools on the other. This cooperation is regulated by law (Vocational Training Reform Act 2005). The agency in charge of supervising implementation of the programmes is the Federal Institute for Vocational Training (BIBB), which is also dedicated to the continuous improvement of the system.

The term dual also denotes a specific constitutional situation in Germany, where the federal government is responsible for vocational training in the companies, and the federal states (Länder) for the vocational schools.

Under this system, vocational training is regarded as a means to achieve a threefold purpose, namely to promote:

- economic productivity;
- social integration;
- personal development.

At present, there are currently about 350 officially recognised occupational standards in Germany. These standards are a central element in the German vocational training system. Although they are incorporated in the state law, trade and industry also play a decisive role in their formulation.

In Germany, more than 50% of all secondary school students decide against university and apply for vocational training, and many companies participate in vocational training courses. Under the dual scheme, companies provide training voluntarily, and often at their own expense.

The main benefit for trainees is receiving market-relevant training that improves their chances in the labour market, while simultaneously improving their social skills and developing their personality through direct theoretical-practical experiences. Finally, the state, too, benefits from the dual system easing the burden on the public budget by participation of enterprises and by keeping the workforce up-to-date.

Source: prepared by the authors on the basis of Euler (2013) Development. For more information see: http://www.germany.info/, http://www.bmbf.de/en/
Box 6. The dual vocational education and training system in Denmark

The Danish VET system is part of the general youth education system, and aims at developing the general, personal and vocational skills of young people. The overall objectives of VET are laid down in the Act on Vocational Education and Training. According to it, the aim of the programmes is not only to provide trainees with vocational qualifications, which are formally recognised and in demand by the labour market, but also to provide them with general and personal qualifications that open up the trainees’ possibilities for lifelong learning and active citizenship.

The system is based on three main principles:

1. The dual training principle, i.e. periods in school alternating with periods of in-company training. This principle ensures that the trainees acquire theoretical, practical, general and personal skills which are in demand by the labour market;

2. The principle of social partner involvement, whereby social partners take direct part in the overall decision-making and daily running of the VET system; and

3. The principle of lifelong learning, i.e. the system is extremely flexible, and offers learners the possibility of acquiring a qualification now and return to the VET system at a later stage to add to their qualifications in order to access further and higher education. Moreover, VET and continuing VET (CVET) are integrated, in order to ensure consistency between different qualifications and competence levels.


In any event, vocational training systems must take into account the needs of trainees, seeking to supplement their secondary or higher education with apprenticeships in the corporate sector, as well as those of companies, particularly SMEs in Medellin and Antioquia, which may have an implicit or explicit interest in STI. This makes it essential to systematically and continuously analyse the needs for training and design and implement training activities accordingly.

The OECD Review of Colombia’s Innovation Policy (OECD, 2014) advocates the strengthening of strategic intelligence, which is considered a solid basis for analysing "bottlenecks" in the overall performance of the innovation system. A recommendation is made to create a high-level unit within Colciencias, or other appropriate entity, which should analyse and identify skill requirements. In the specific case of Medellin, an important part of the Action Plan is the creation of an observatory; i.e., a tool to analyse, monitor and evaluate the strategies aimed at developing the competences required by Medellin’s human capital to meet the demands of the STI system. Such strategies must be coordinated with the national level, with two objectives:

1. To capture and analyse the evolution of the skills and training required by the business sector so as to provide systematic guidance to the establishment of priorities and modes of action based on actual demand;

2. To monitor and evaluate the STI-related skills and capabilities of the human resources of Medellin. This intelligence should make it possible to monitor the progress achieved in terms of generating high levels of qualified employment and creating, attracting, retaining and developing qualified human resources for STI.

A functional platform must be developed to manage the implementation of a specific action plan, enlisting the support of existing coordination agencies (e.g., CUEE) to decide on the division of labour between the various educational institutions (secondary professional and academic), government and...
enterprises (See Box 3). The following recommendation includes the need for this "governance infrastructure" accompanied by multiple stakeholders.

**Strengthen coordination between all actors in the educational sector**

As mentioned above, the benefits of human capital development and maintenance are usually observed only in the long-term. For this reason, continuity of these activities and the reinforcement of coordination between the relevant local stakeholders are crucial to ensure a successful result.

Government institutions responsible for the design of educational, employment and business competitiveness policy at local, regional and national level should incorporate staff specifically devoted to the development of STI capabilities so as to create a strategic platform for human capital that makes it possible to overcome the current inefficiencies of the local innovation system.

Based on these considerations, creation of a coordination body is recommended as it would provide a permanent horizontal and vertical coordination system, involving agencies at various levels of government as well as educational and training institutions, companies, and trade unions. Ruta N could play the role of facilitator or catalyser in such an initiative.

An important function of this collegiate body would be to ensure continuity of action, compensating for potential changes in the member institutions as a result of elections, appointment of new management of academic institutions, etc.).

This body can be established as a new collegiate entity by enlisting the players mentioned above. Nonetheless, considering the number of existing entities, agencies and coordination groups, it would be preferable to assign the functions of the new body to one of these already existing actors, for example to CUEE, whose participation in the design of the Action Plan is already envisaged. Ruta N could perform the duties of technical secretariat.

This body would act as a "monitoring committee" for the implementation of the Action Plan, providing detailed definitions of its objectives, responsibilities, working modalities, procedures, etc. It would also be entrusted with promoting a better match between the supply and demand of human resources in STI and the exchange of information on the implementation of the Action Plan in terms of human capital and its various activities.

The following functions should also be performed:

- Formulate policy decisions aimed at the development of STI-driven human capital based on first-hand information and direct knowledge of the current situation;
- Adapt the curricula of public and private educational institutions to emerging needs in STI;
- Facilitate coordination and integration of STI-oriented training and capacity-building activities with the policies and programmes of educational institutions at national, regional and local levels. This will reduce current inefficiencies (complex transition from school to university, weaknesses in the generation of technical-professional profiles), featured in the OECD Review of Colombia's Innovative Policy (OECD, 2014) and also relevant to Medellin's case;
- Quantify and update, with the assistance of entrepreneurial associations, the business sector's need for STI-driven staff and the human resources requiring greater attention;
Act as a facilitator, primarily through inter-government and intersectoral agencies (Ruta N in the first place), providing updated information; monitoring the whole training process; and disseminating - through information and awareness-raising actions – national programmes and initiatives at local level (e.g., Colciencias).

**Generate STI-qualified human capital throughout the business fabric**

The first part of this chapter showed that the business system of Medellin and Antioquia is composed of a minority of companies that have their own vision on innovation and, since they are very large or operate in knowledge-intensive sectors, set the tone for the local innovation system. However, over 90% of the local businesses in the area are micro or small, and are left out of any formal innovation process.

Leading companies are already active and investing in strengthening their human resources, cooperating with the educational institutions and seeking the advice of agencies and programmes that have developed locally as a result of the strategic importance given to innovation in Medellin.

Other companies, by contrast, tend to be reluctant to invest in their human capital. Their limited resources, knowledge, strategic vision, and corporate culture negatively hinder their insertion into the innovation system as well as their potential to attract more skilled human resources.

Clearly the two groups of businesses require very different strategies, and potential action in both cases should also be different.

Leading knowledge- and innovation-intensive companies, should:

- Undertake or strengthen measures aimed primarily at ensuring that the local supply of skilled human resources (researchers, technicians, innovation process experts, sector specialists, etc.) matches the needs of businesses. One of such measures could involve the establishment of a monitoring system of existing human capital and skills needed for innovation (see the first recommendation related to the development of an integrated system aimed at analysing, monitoring and evaluating changes in Medellin's human capital in STI);

- Facilitate cooperation between companies and local educational institutions in the design of curricula aligned with the specific needs of the business sector and the strengthening of the university-industry link. An outstanding international example is the cooperative education programme of the University of Waterloo in Canada, based on a mutual engagement between universities and industry whereby academic training is complemented by in-company apprenticeships;

- Provide specific training initiatives, such as continuous training programmes, geared to persons in employment in the corporate sector through cooperation with secondary and higher education institutions (inspired by international examples of dual vocational education and training, such as the Danish VET programme); and

- Encourage the mobility of local STI-qualified personnel between companies and R&D centres for activities dedicated to innovation projects in order to facilitate the exchange of knowledge, insights and experiences.
CHAPTER 2: HUMAN CAPITAL: STRATEGIC ENabler FOR THE LOCAL STI SYSTEM | 57

Box 7. Co-operative education at the University of Waterloo in Canada

The University of Waterloo operates the largest cooperative education programme in the world, with more than 11,000 students (60% of total) and 3,000 employers, 281 of them local, participating in the programme each year.

The region of Waterloo in Ontario, located about 100 kilometres west of Toronto and also known as Canada’s Technology Triangle (CTT), benefits from the strengths of a dynamic local labour market that results from a strategic decision taken at the creation of the institution. The founding charter of the new college in 1957 declared a resolve to pioneer a new kind of education built on cooperation with the business sector.

Still today the cooperative education programme of Waterloo plays a crucial role in the local innovation system.

Under the cooperative scheme (made up for 140 cooperative programmes, the University, in collaboration with students and companies, aims to:

- Facilitate, through a competitive employment process, access to meaningful work opportunities related to the students’ academic duties and aspirations.
- Ensuring access to various employment opportunities both in Canada and internationally and drawing enterprises towards Waterloo’s rich talent pool.
- Supporting students in acquiring, reinforcing and enhancing the capabilities required in a knowledge-driven economy and the global labour market.

Source: Website of the University of Waterloo [https://uwaterloo.ca/co-operative-education/](https://uwaterloo.ca/co-operative-education/) and [http://www.cecs.uwaterloo.ca/about](http://www.cecs.uwaterloo.ca/about)

As regards micro and small companies, steps should be taken to stimulate their ability to realise the advantages inherent in having innovation-oriented human capital in their payrolls. Strategies vis-à-vis these companies should depend on their different stages of development: existing and well-established traditional companies, companies undergoing strategic changes, and newly established businesses.

On this matter, the following recommendations are presented:

- Stimulate innovation-oriented capabilities and attitudes through awareness-raising and animation activities;
- Provide permanent cycles of training programmes for entrepreneurs, managers and employees creating synergies and forming partnerships with training institutions already offering such programmes (e.g., SENA, which provides specialised continuing education as part of its Alianzas para el Trabajo collaborative programme _ftn2);
- Define potential action oriented to upgrading the qualifications of human resources, through the development of integrated education and training programmes and support services.

A serious problem facing the corporate sector in Colombia is the so-called inverted pyramid predicament, i.e. the scarcity of personnel with professional technological and technical training relative to

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Note:

the high availability of university graduates. This problem was highlighted in the OECD Review of Colombia’s Innovation Policy (OECD, 2014), which states that one of the factors leading to the current situation is related to the little importance attributed to enterprises as creators of human capital and the limited recognition awarded to professional profiles. This problem can be tackled from the perspective of the educational offer as well as by enhancing the recognition attached to the role played by technological and technical professionals in the enterprises they work for.

The leading vocational training institution in Colombia in terms of experience and recognition is SENA, which runs various vocational training, apprenticeship and job placement programmes and is active in supporting technological innovation in the business milieu. Among others, SENA’s rich offer includes the SENNOVA programme (Sistema de Investigación, Desarrollo Tecnológico e Innovación) as well as various initiatives to encourage innovation in enterprises. SENA also has regional centres, being particularly active throughout Antioquia. It is recognised as a strategic partner of Ruta N.

A strategic partnership between Ruta N and SENA could be envisaged, perhaps initially for a pilot for Medellin. Given the strategic approach and complementary capabilities of each institution, their coordinated action could contribute to enhancing the supply of skills, not only in industries identified as a priority by the STI Plan (healthcare, energy and information and communication technology), but also in the more traditional sectors of the local economy. Rather than create new joint initiatives or programmes, existing initiatives by SENA and Ruta N to address the specific needs of the local system should be strengthened through an effort of coordination and integration.

Awareness-raising campaigns should be put in place to improve the social recognition and remuneration of technical professionals. In European countries, where efficient vocational training systems are in place (see Boxes 5 and 6 above for examples of the German and Danish cases), technical professionals enjoy some measure of social recognition, which often implies a higher wage. Informative and publicity activities should be organised including competitions to recognise outstanding technicians in local companies (the concept developed by Ruta N’s Comuna Innova initiative could be adapted and used for this purpose). Advocacy work is also required to influence businesses to make sure that the wages of their technical staff are progressively increased.

With regard to more skilled human resources, actions must be undertaken to create or strengthen the set of innovation-related skills available to different local entities (agencies, local governments, education and training institutions, etc.) so that they develop a critical mass of STI-experts who can effectively represent the position of their institution and, at the same time, act in accordance with a shared systemic vision. These actions may include seminars, workshops and training initiatives aimed at developing a common language that each person can use to express their view of their role within the local innovation system. The training of innovation facilitators recommended below is intended to generate and distribute qualified human resources across the local system.12

In addition, measures should be put in place to facilitate the exchange of experts between the mentioned institutions through internships, exchanges, etc. so as to facilitate mutual understanding of the needs, possibilities and roles of each institution and develop synergies and more efficient forms of cooperation.

**Generate demand for innovation-oriented human capital**

Strengthening the STI system requires enlarging the number of companies that are active in the field of innovation or are at least potentially interested in innovative practices.

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12 See section “Generate demand for innovation-oriented human capital” further in this chapter.
The following steps should be taken in order to increase the number of innovative local companies (for further discussion see the chapters below):

- Generating new knowledge-intensive businesses;
- Attracting innovative and technology-intensive companies;
- Strengthening and encouraging the development of the so-called traditional local businesses through innovation.

Success of these actions will in each case depend on the type of human capital available in the company and in the local context. This creates the need to define alternatives in terms of the human resource development actions feasible in each case, for which local companies will need the assistance not only of high standard educational and training institutions, but also of efficient business support services.

Examples of these support services include:

- Development of diagnostic and technology monitoring programmes aimed at improving small business performance;
- Assistance in the creation of "non-technological" start-ups so that they too become aware of the value of STI (in traditional sectors or less developed sectors);
- Support for technological start-ups to improve their innovation and business management capabilities (this may include the “innovation enablers scheme” whereby funds are made available to entrepreneurs to hire an expert to support them in launching their company);
- Stimulus to the generation of associations of firms and the establishment of collaborative R&D projects between companies and STI centres;
- Assistance to foreign investors in finding qualified personnel.

Providing these services often makes it possible to identify specific training needs that have to be addressed in order to meet the demand for skilled human resources.

To ensure effective identification and diagnosis, companies must submit a detailed formal request specifying their needs. A formal proposal for specific training actions must then be drawn up by training and education institutions. The required training will benefit from co-funding in the framework of existing business innovation and start-up support projects. A partnership between Ruta N and SENA, suggested above, is an example of the steps that could be taken in this direction.

The implementation of these actions makes it necessary for consulting firms, universities, business incubators, cluster management organisations, agencies, etc. to be equipped with the skills and capabilities required by the highly developed STI system Medellin and Antioquia aspire to have.

In order to generate these capabilities and skills, several countries have created innovation facilitator programmes. Facilitators are no other thing than entities whose role is to facilitate the development of innovation and the transfer of technology within the business sector (e.g., technology platforms, technology centres, and science and technology parks). Another option, which in the opinion of the authors
is better suited to the case of Medellin, is to make available at local level qualified professionals with expertise of innovation processes.

An innovation facilitator is a professional in a company, whether employed by the firm or specifically hired for the task, whose job is to promote a culture of innovation, thereby improving internal management of innovation and R&D activities.

The innovation facilitator must meet the following requirements:

- Must have extensive experience;
- Must be either an employee of the company or external to the organisation;
- Must change a company’s “passive” attitude towards innovation to a more proactive and participative role in the performance of innovation activities.

In short, the facilitator must strive to encourage companies to adopt a proactive attitude in terms of innovation, making them aware that innovation is a continuous rather than a discrete process.

For the case of Medellin, specific actions should be carried out to generate innovation-driven skills and capabilities, with a view to developing qualified human resources in the local innovation system who can act as facilitators to accelerate the corporate demand for innovation and to establish links between companies and the various institutions offering STI services.

Programmes should also be designed to support MSMEs that are not open to innovation so that they, too, can benefit from the assistance of innovation facilitators, especially considering that the facilitator’s duties include the responsibility to encourage firms to undertake innovation processes.

Two interesting examples from this point of view are provided by the Canary Islands (Spain) and Denmark, where initiatives were put in place to focus, respectively, on generating and harnessing local experts to act as facilitators of innovation processes in MSMEs.
Box 8. The experience of the Canary Islands (Spain): Innovation enablers

The Government of the Canary Islands, through the Canarian Agency for Research, Innovation and Information Society (ACIISI), trained over a 4-year period a total of 12,954 people as innovation facilitators and invested EUR 5,094,220 in the period 2008-2011 (EUR 393 per student on average).

The purpose of the programme is to promote entrepreneurship among both professionals and entrepreneurs, especially those operating in mature markets unlikely to change their competitiveness status due to a lack of innovation culture. Ultimately the goal is to introduce, in the short-to-medium term, a change in the traditional economic model of the Canary Islands without undermining strategic and consolidated sectors, but increasing the specific weight of other equally critical emerging sectors for the sustainable development of the archipelago.

The programme, addressed to different groups, is intended to provide training for the following professional profiles:

**Innovation promoter:** this is the most basic profile yet the one offering the broadest scope. The training is directed to professors, technical staff, middle managers, graduates, investors, professionals, entrepreneurs, university and vocational training students, and research staff. The course provides an introduction to the knowledge-based economy model, business innovation strategies and diagnostic tools. Guidance is also offered to identify opportunities for improvement, informing students of available aid programmes and of public and private innovation service providers.

**Innovation agent:** this profile seeks to meet the business-driven demand for innovation project managers. Aimed at a broad group of trainees (professors, technical staff, middle managers, graduates, investors, professionals, entrepreneurs, university and vocational training students and research staff), this course provides the skills needed for formulating proposals, preparing budgets, performing economic feasibility studies and planning for and implementing projects. Trainees will also acquire relevant knowledge to provide economic justification for innovation projects.

**Innovation consultants:** this profile requires being in possession of the knowledge necessary to conduct a business innovation consulting project, which encompasses analytical and diagnostic services, technology monitoring, identification of opportunities, proposal development as well as the drafting, planning, implementation and completion of innovation projects. The training is directed to recent university graduates. Trainees that successfully complete this course can apply for internships in companies and university research centres.

**ICT Advisers:** under this category, information and communications technology specialists are trained to meet business needs in this area and participate in the technology voucher programme as service providers. It is aimed at recent graduates with scientific and technological degrees.

Box 9. The Danish Technology Partnership Programme

The TPP (Technology Partnership Programme) is a knowledge brokerage system that helps innovative companies gain access to state-of-the-art knowledge, and helps members of the global network of knowledge institutions market their knowledge and build partnerships with companies and other institutions.

In the summer of 2007, the Danish Agency for Science, Technology and Innovation launched a three-year pilot project to stimulate innovation in small and medium enterprises. The Danish Technological Institute was selected, along with two other national agencies (FORCE Technology and DELTA), to implement the project.

"Innovation facilitators" is the name of the initiative that aims to offer companies an innovation check-up through the expertise of DTI consultants acting as innovation facilitators for companies. Consultants identify the most important development opportunities for businesses and work closely with regional development agencies and business advisory offices to provide businesses with a single access point to the public innovation system.

Innovation facilitators are responsible for actively seeking SMEs and putting them in contact with relevant STI institutions so that the relevant innovation programme may be developed.

In 2007 the Danish Technological Institute supported 65 companies in Central Denmark. The development of their new innovation programmes entailed a total allocation of EUR 4.0 million.


Improve the connections between the supply and demand of qualified personnel

Achieving an effective match between supply and demand of STI is critical for the design of a local innovation strategy. In many cases, despite the availability of local knowledge, structural weaknesses exist that prevent the transfer of such knowledge to the business fabric. This means that the knowledge cannot be transformed into innovation or economically tangible results.

This phenomenon is recognised as a weakness of the European STI system against its direct competitors (especially the USA): the gap between basic knowledge generation and the subsequent commercialisation of this knowledge in marketable products has commonly been identified and is known in broad terms as the "valley of death" issue. Its effects can include not only relocation of manufacturing and R&D, but also the disruption of entire value chains with their ultimate consequences on the sustainability of the various strategic sectors in Europe.  

A bridge is needed to cross this valley. At the European level a strategy comprising three supporting pillars is recommended:

- A pillar focused on technological research;
- A product demonstration pillar, focused on product development at enterprise level;
- A production pillar focused on world-class advanced manufacturing (EC, 2011).

13 See the first recommendation on smart specialisation strategy in Chapter 5 for further detail on the design of a strategy geared to minimising the risk of failing to close the gap between generation and application of knowledge.
This critical gap is also relevant in the specific case of Medellin. According to an analysis carried out of the local STI system, the most effective way to address the challenge is to design an effective smart specialisation strategy.

The problem is the result of several structural factors inherent in Medellin's local systems and several actions can be taken to address current weaknesses. Among them, increasing the availability of skilled human capital would obviously constitute a step in the right direction.

It is then necessary to facilitate the establishment of a virtuous link between the supply and demand of qualified personnel, so that companies can benefit from an abundance of personnel with experience and specific knowledge to perform different functions, but who are also capable of effectively interacting with each other within the system.

There are several methods and tools that can be adopted, taking advantage of the services and funding provided by different local institutions (Colciencias, SENA, etc.), to ensure that supply of human resources matches the demand. Some examples are the following:  

- Scholarships for researchers and introduction of higher education and doctoral programmes based on corporate experiences;
- Advanced in-company learning systems (such as those exemplified by dual training programmes);
- Co-operative higher education programmes (following the model of the University of Waterloo in Canada); and
- Staff exchanges between R&D centres, universities, companies, etc.

In order to achieve an effective match between supply and demand, the aforestated initiatives must be part of complex innovation-driven projects and programmes where actors of the demand side - primarily companies - and those on the supply side, establish a stable strategic link.

A positive and promising example of these actions is the recent round of applications launched by Ruta N Cooperación N: Convocatoria Redes de Cooperación Internacional, Plan CTI where the goal is to strengthen the internal capacities of research groups, companies and institutions by setting up knowledge networks involving international partners. This would help enhance the results of projects in the fields of science, technology and innovation. Under this system, the benefits of promoting a balance between the forces of supply and demand in a context of international networks could be substantial.

The focus then should be placed particularly on the development of initiatives that create a strategic platform aimed at encouraging better coordination between supply and demand of STI-qualified personnel.

Internationally, several important experiments have been conducted to support the mobilisation of human capital between the business sector, academia and STI centres. The box below presents some specific cases.

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14 See Chapter 3 for further detail on the role of Colciencias.
Box 10. Experiences of coordination between the supply and demand of STI skills

Zhejiang University in the Regional Innovation System of Hangzhou, China

Zhejiang University is one of the biggest universities in China. It is located in Hangzhou, in the economic circle of the Yangtze River Delta, the most economically developed region of China. The University trains large numbers of high quality talents with a view to meeting the demand for professionals capable to transform and modernise the local economy.

Innovation vouchers, Netherlands

The main objective of the innovation vouchers system is to bring SMEs closer to public STI institutions. The voucher generates two main effects: first, it allows SMEs to purchase services from knowledge providers in order to introduce innovations in their business operations, an opportunity that would not be within their reach in the absence of such incentives; Secondly, vouchers are an incentive to encourage experts from STI institutions to work with SMEs when their natural tendency might either have been to work with larger companies or have no industry engagement at all. As a result, the Innovation voucher can be considered a vehicle for demand-based knowledge transfer.

NITEC – Support R&D units in SMEs, Portugal

The NITEC programme is aimed at encouraging the creation of R&D units in SMEs. A three-year grant is provided to cover the salary of hired scientific and technical personnel. The main objectives of the NITEC programme (Núcleos de Investigação e Desenvolvimento Tecnológico no Sector Empresarial) are: (1) to support the creation of homegrown R&D competencies in Portuguese companies; (2) to support the efforts of Portuguese companies to improve their design and process capabilities and acquire direct technological knowledge; and (3) to promote the ability of Portuguese companies to develop technologically innovative products and solutions.

An interesting example of activities aimed at encouraging mobility of STI experts within the system is the Researcher Mobility Programme of VINNOVA, the Swedish Innovation Agency.

The programme is interesting in that it brings together different stakeholders in order to promote researcher mobility at local, national and international level.
Box 11. VINNOVA Mobility for Growth Programme

The VINNOVA Mobility for Growth programme is implemented through partnerships between universities, research institutions, research infrastructures, businesses, SMEs and other socio-economic actors from different countries in Europe and worldwide.

The programme is the successor of VINNMER programme, which in the 2007-2014 period invested about EUR 60 million.

The long-term goal of the programme is to manage the coming generational changes in Swedish research, by contributing to the presence of significantly more research-qualified individuals who can become future leaders of universities and colleges, centre groupings, research institutes and companies.

The general objectives of the programme are:

- Intersectoral Mobility: promoting mobility between the public and private sectors.
- Transnational Mobility: promoting researcher mobility and developing attractive careers.
- R&D-qualified future leaders: advancing the demand for training and skills by enhancing human resource management in highly competitive environments.
- Equal Opportunities: advocating and promoting a better work/life and gender balance through flexible work arrangements under full-time contracts.
- Supporting mobility as a merit: A mobile career should be a strong future merit in all sectors performing R&D.

In terms of the results expected from the programme, a total of more than 100 researchers are due to receive grants to obtain higher qualifications or further their academic career over the period 2012-2017.

Source: VINNOVA’s website, http://www.vinnova.se/

A final recommendation: strengthen multilevel governance in the development of human capital for STI in Medellin

The various recommendations made in this chapter are not exempt from complexity but are essential on the path towards development and consolidation of a globally competitive local innovation system in Medellin.

Some of the factors determining the complexity inherent in the task ahead are as follows:

- Scarcity of world-class academic, vocational training, research and development, technology transfer, and competitiveness development centres;
- Multiplicity of stakeholders, which poses the risk of overlaps and even destructive competition in the performance of the planned actions. This undermines the efficiency of the system;
- Need to develop a long-term time perspective in order to achieve effective and sustainable results;
The local context comprises both tangible factors (investments and resources, generation of new innovative companies, increasing competitiveness of the system, installed educational capacity, etc.) and intangible factors (attitudes of employers and other stakeholders, local idiosyncrasies, perception towards the future and strategic orientation, etc.);

- Medellin’s innovation strategy must focus on knowledge-intensive sectors in a business context dominated by traditional sectors linked to effective territorial assets (the coffee sector in Antioquia, for example);

- Need to connect the local target (Medellin) with its regional and national context.

All the above leads to the imperative need to design a system of governance that allows effective joint action within a constantly evolving system, where human capital is a concurrent and decisive factor at the same time: it is concurrent since capacity-building initiatives must enjoy not only the approval of but also a shared commitment by people and institutions; and it is decisive because the ability to guide the development of human capital through a series of effective actions implemented over time will be the make or break factor for the success of Medellin’s innovation strategy.\(^{16}\)

The need for a multilevel governance structure is also identified as a prerequisite for undertaking effectively coordinated actions for the development of innovation-driven human capital in Medellin. This is one of the cross-cutting strategic goals considered in this Review and implies the ability to establish a link between the different stakeholders both in a vertical dimension (between institutions in Medellin and those at department and national level), and a horizontal level (between the entities that play an important role in the local fabric).\(^{17}\)

Acting locally implies, besides the initiatives taken directly and autonomously at the local level, channelling and coordinating all existing opportunities at the department and national level to promote Medellin’s local context; but, perhaps more importantly from a strategic point of view, it also implies the ability to design and implement a local strategy that is aligned with national and department-level strategies.

At the same time, an efficient governance structure is crucial at the horizontal level, so that all the different local stakeholders that share an interest in human capital and local innovation in Medellin, can join forces and achieve sufficient critical mass in a context of limited resources.

Finally, the discussion above further demonstrates the urgency to formulate an action plan for STI-qualified human capital, whose design should be shared between the various relevant stakeholders. To ensure the success of this endeavour, connections between such stakeholders should be strengthened through the establishment of an entity that coordinates their various actions and subsequently monitors the implementation of the Plan in order to ensure effective multilevel governance.

\(^{16}\) The concept of “concurrence”, defined during the local development planning stage, denotes an interdisciplinary, multi-sectoral and participatory planning process simultaneously covering multiple subject areas. A notable case of concurrent planning is Barcelona’s District 22@.

\(^{17}\) See section “Towards a new innovation policy agenda for Medellin” in Chapter 1.
References


CHAPTER 3

INTENSIFICATION OF INVESTMENT IN R&D ACTIVITIES ORIENTED TOWARDS THE SOCIO-ECONOMIC DEVELOPMENT OF THE REGION

The improvement of Medellin’s innovation system requires stepping up efforts to increase investment in research and development (R&D), through new policy strategies aimed at enhancing the existing research groups and attracting new projects and funding streams. This chapter discusses how to strengthen the scientific base of the city, with special emphasis on the role of universities and public research centres, while Chapter 4 focuses on business innovation, notwithstanding that both elements are closely related.

Besides the objective of generating new knowledge, investment in R&D in developing countries or regions is especially necessary to improve absorptive capacity, i.e. the ability of the country (or region) to identify, select, acquire, adapt and exploit existing knowledge from abroad that may contribute to its socio-economic progress (Criscoulo and Narula 2008; Pietrobelli and Rabellotti, 2011). It is also important to consider that R&D investment in universities is essential to ensure high quality education of human capital, especially at postgraduate level, as discussed in Chapter 2. Furthermore, due to the magnitude of the social challenges that Colombia and particularly Medellin are facing, legitimising investment in R&D over other public spending alternatives was no easy task. It thus becomes necessary to link more clearly the research agenda with social needs and establish monitoring and evaluation mechanisms that make the results visible to civil society.

Indeed, one of the major challenges of Colombian science and technology policy is to balance regional cohesion and inclusive innovation with the need to promote competition and funding based on excellence, as a way to promote scientific quality. On the one hand, the commitment to increase investment in R&D is fully justified due to the lag of Colombia compared to other countries in the region and, above all, due to the importance of R&D as a lever to promote the diversification of the economy, increased productivity, and economic growth in the long-term. On the other, given the prevalence of poverty, inequality, and the informal economy, new mechanisms are needed to better link economic and technological progress with other social objectives so that the results of R&D are more inclusive.

In almost all the countries of the world, public funding of R&D occurs through a combination of mechanisms of direct funding to institutions (i.e. annual contribution to the budget of universities and public research centres) and competitive funding (i.e. calls for research projects and centres of excellence programmes). While it is important to ensure some stability in the funding of universities and public research centres, an increasingly widespread trend among OECD member countries is to promote competition and provide incentives to reward scientific excellence, introducing periodic evaluation mechanisms to provide more funds to the most productive universities and research centres (Hicks, 2012; OECD, 2011). This selective approach is used not only to improve scientific productivity but also to guide research activities towards a set of technologies or priority sectors. The current strategy in Medellin focuses on guiding R&D efforts towards immediate market needs, concentrating resources on three priority sectors (energy, health and ICT) in order to obtain visible results in the short-medium term that justify the continuation of public investments.

This decision to focus scarce resources in strategic sectors and projects with a clear commercial vocation is consistent with the characteristics of Medellin’s innovation system, but at the same time
involves some risks. In particular, it may be detrimental to the advancement of basic research, since the latter depends to a greater extent than applied research on public funding. Universities and public R&D centres must not be discouraged from engaging in research with no short-term commercial application, because it could eventually be translated into new technologies with greater social impact and contribute to long-term economic growth. In addition, basic research is necessary for the training of good scientists in universities as they are endowed with the necessary knowledge to absorb new technologies. In sum, it should be stressed that applied research is only possible if based on the solid foundations of basic research (Santamaría et al., 2013).

The relative importance of basic and applied research has sparked an intense debate in the literature that is still ongoing. No easy formula exists to determine what percentage of public funding should be devoted to the different categories of R&D in accordance with a country’s characteristics. Far from this, this area is full of uncertainties. In OECD countries for which data are available, basic research accounts for 20% of total (Arnold and Giarracca, 2012). Nonetheless, the need to invest in basic research is possibly lower in developing countries such as Colombia, where efforts should focus not so much on expanding the frontiers of knowledge as on absorbing, adapting, disseminating and applying internationally available technology, for which applied research is of the essence. In any event, distinguishing between basic and applied research may lead to a futile debate (Narayanamurti et al., 2013) as what is really important is for public funding to be based on excellence and transparency criteria, striving to offer greatest support to the best research groups, applying clearly specified evaluation criteria.

Ultimately, public funding for research in Colombia and Medellin, in particular, is facing a series of dilemmas that require a constant need to balance between social innovation and technological innovation oriented to market needs; between basic research and applied research; between support for business innovation and public research centres; between the short and the long-term; etc. This calls for a careful selection of a flexible mix of policies that impinge proportionately on different objectives, in spite of the limitations of the public budget (Borrás and Edquist, 2013).

Moreover, the design and articulation of science and innovation policies must rely on an efficient multilevel governance framework, through mechanisms of horizontal (between ministries) and vertical (between different levels of government) coordination. In the case of Medellin, a challenge that has become more relevant in recent years is the gap between the priority research areas for the city and the needs of the region of Antioquia as a whole. Indeed, the research agendas of Medellin’s universities and R&D centres are becoming increasingly focused on the three priority clusters of the STI Strategic Plan (energy, health and ICTs). At the same time, the Antioquia Development Plan 2012-2015 has defined ten priority productive areas: avocado, cocoa, rubber, citrus fruits, small fruit, dairy products, mining, fish farming, reforestation, and tourism. This local-regional dislocation is due to the fact that the productive structure of Medellin is very different from that of the rest of Antioquia. Outside Medellin, Antioquia is mostly a rural region, where agriculture and mining activities predominate, with low-skilled labour, especially around the cultivation of coffee, avocado, rubber and banana, as well as gold mining. However, there are very few research groups in Medellin’s universities showing an interest in these areas.

Universities and research groups of Medellin

Medellin has around 30 public and private higher education institutions, but only a small part of them engage in research. Among the city’s universities, the University of Antioquia, the National University of Colombia and EAFIT stand out (OECD, 2012a). The University of Antioquia is the oldest in the region. Established in 1878, it has about 35,000 students, which makes it the second largest university in the country. This public university is also the leader in the region in terms of R&D activities, hosting most of the research groups in the city in a variety of scientific disciplines. In, 2012, over 40% of the University’s professors had a PhD, a figure which barely reached 5% in 1980 (Vargas et al., 2013). It is the only
university in the region that can become in the short term a regional and even international leader in research. The other most notable public university is the National University of Colombia, the largest university in the country. The University has a campus in Medellin, especially known for its engineering faculty, with about 10,000 students. As for the private universities, the most remarkable is EAFIT, founded in 1960 by business associations, which currently has about 9,000 students, and is particularly noted for its applied research activities and its close links with industry, government and entrepreneurship. The other universities in the city are San Buenaventura University, the University of Medellin, Universidad Pontificia Bolivariana, Metropolitan Technological Institute, Luis Amigo University Foundation, Antioquia Engineering School, Politecnico Jaime Isaza, Catholic University of the East, CES University, and Lasallista University Corporation, among others.

Although at different rates in different universities, during the past two decades there has been a shift from an exclusive focus on teaching towards a greater emphasis on research (OECD et al., 2013). This process has been accompanied by a significant increase in the proportion of professors holding PhD degrees and a professionalisation of research management through the appointment of deputy rectors for research, the intensification of university-industry collaboration, and the creation of new technology transfer offices in almost all universities. However, most of these technology transfer offices of universities and the vocational training centres in Medellin have not yet achieved a critical mass and have not been able to adopt international best practices regarding transfer and commercialisation of technology (Genesis, 2009). To compensate for these weaknesses, in 2005 the Tecnova agency was created, a non-profit-making organisation promoted by major universities in the region with the objective of providing research groups with market intelligence services, pilot testing, patent management, industrial partner search, and other services for the commercialisation of research results.

In addition, many experts complain that the current incentive system is inadequate and, in particular, that labour laws and the Constitution obstruct the participation of researchers from public universities in collaborative projects with companies and spin-offs, given the rules related to incompatibilities, which in principle do not affect private universities. As evidenced by Zuñiga and Correa (2011), this type of institutional barriers is common in many developing countries and limits the entrepreneurial capacity of universities, as well as the propensity of researchers to become involved in the commercialisation of technology. To address this issue, since 2013 a working group driven by Tecnnova and the University of Antioquia has been conducting a legal study, to be published shortly, aiming to formulate a proposal to solve this problem. Currently this initiative has the support of Colciencias and other universities and legal experts seeking clarification on the interpretation of the regulatory framework and the necessary reforms.

In recent years, universities have focused on the development of research programmes tailored to the needs of the local industry, in collaboration with firms and public agencies. This collaborative university-government-industry relationship has resulted in the emergence of a wide variety of research groups, institutes and centres oriented towards the needs of industry and financed by the private sector. Noteworthy is the creation of centres for research and technological development in different sectors (e.g., from software or power supply) that carry out important applied R&D and technology diffusion work. Some of the most relevant centres present in Medellin include the Centre for Research and Innovation in Energy (CIIEN), the Innovation Centre for Biodiversity and Biotechnology; the Centre for Science and Pharmaceutical Research; the Corporation Centre for Research and Technological Development of the Electricity Sector; the Institute for Training and Research in Plastics and Rubber; and the Centre for Research and Development of the Construction Industry, among others. Another relevant example is ARTICA, a partnership between the telecommunications company UNE (belonging to the EPM group) and a number of local universities (EAFIT, Universidad Pontificia Bolivariana, University of Antioquia, the National University, and IPS University) to develop applied ICT innovation projects. It is also important to highlight the research activities carried out by the Hospital of Medellin, both independently and in collaboration with universities, especially with the University of Antioquia.
The scientific production of Medellin-based universities and research centres is an important part of the national total, as evidenced by a recent study of the Colombian Observatory of Science and Technology (Ruiz et al., 2013). According to this study, between 2001 and 2010, the region of Antioquia produced 5,569 scientific articles indexed in either Web of Science or Scopus, representing 22.3% of the national total, only behind Bogota that accounts for 38.9%. As shown in Table 3, Antioquia has a total of 738 research groups classified by Colciencias, the vast majority of which are located in Medellin. This represents 13% of the national total. If we focus on higher quality groups, those in Colciencias’ A1 or A categories, Medellin has 104, which represents 21% of the national total in these categories. Therefore, a high quality presence of research groups is detected. In terms of human resources, note that the 738 research groups of Medellin bring together 1,932 researchers (13% of researchers in the country), implying that each group has an average of 2.6 researchers. It is also noteworthy that Medellin hosts 47 of the 155 existing doctoral programmes in the country (OST, 2013).

Table 1. Regional distribution of Colombian research groups classified by quality

<table>
<thead>
<tr>
<th></th>
<th>A1</th>
<th>A</th>
<th>B</th>
<th>Other</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bogota</td>
<td>94</td>
<td>98</td>
<td>272</td>
<td>1,795</td>
<td>2,259</td>
</tr>
<tr>
<td>Antioquia/Medellin</td>
<td>45</td>
<td>59</td>
<td>100</td>
<td>534</td>
<td>738</td>
</tr>
<tr>
<td>Rest of the country</td>
<td>77</td>
<td>118</td>
<td>295</td>
<td>2,067</td>
<td>2,557</td>
</tr>
<tr>
<td>Total</td>
<td>216</td>
<td>275</td>
<td>667</td>
<td>4,396</td>
<td>5,554</td>
</tr>
</tbody>
</table>

Note: Since 2009 Colciencias has classified research groups into different categories according to their quality, measured by various scientific indicators (publications, patents, etc.). The A1 category refers to the highest quality groups, followed by the categories A, B, C and D. Source: Prepared by the authors on the basis of OST 2013.

Some initiatives to strengthen collaboration among universities aiming to coordinate agendas and avoid fragmentation have been recently developed. An example is the formation of the so-called G8, a forum for dialogue where the rectors of the eight major universities in Medellin meet. Equally important is the creation in 2013 of the Sapiencia Alliance, a partnership between public universities in the municipality of Medellin (Metropolitan Technological Institute, Colegio Mayor de Medellin and Pascual Bravo University Institute) to build synergies around infrastructures for training, dissemination, university-industry collaboration, management skills and technology transfer. Moreover, within the University of Antioquia, the Sede de Investigación Universitaria (SIU) was created, which brings together the leading laboratories and research groups in order to increase collaboration and share laboratories and equipment, as well as improve the ability to raise private funding for R&D.

Nevertheless, a clear limitation to Medellin’s innovation system is the insufficient critical mass and the fragmentation of research efforts. In recent years R&D expenditure in Antioquia stood at 0.37% of GDP, which is twice the national average, but still very modest compared not only with advanced regions in developed countries, but also with other regions in Latin America. Although Medellin has many universities, none of them (nor any Colombian university) is among the top 500 of the Academic Ranking of World Universities (ARWU), while other countries in the region have managed to place some of their universities in this recognised international ranking. 18 Universities in Medellin are still characterised by the presence of too many dispersed research groups, which operate with small budgets and few researchers per group. Perhaps a higher concentration of these groups could allow better coordination of research agendas.

18 Ten Latin American universities feature among the world’s leading 500 universities in the 2013 edition of ARWU: Six from Brazil, two from Chile, one from Argentina and one from Mexico. Amongst them, the highest score goes to the University of Sao Paulo (top 101-150), followed by the National Autonomous University of Mexico and the University of Buenos Aires (top 151-200). Note that from position 101 onwards, universities are ranked in groups of 50. Further information at: http://www.shanghairanking.com/
so as to avoid duplication and leverage synergies. Moreover, universities in Medellin have 47 doctoral programmes in various disciplines, so it would also be important here to explore merger or partnership opportunities between different programmes in related fields. Later, a set of recommendations in this direction will be presented.

Key issues for policy

The new STI fund

In 2011 a new system to manage the royalties obtained by the government from the exploitation of mineral resources was established. In the past, the eight richest departments in mineral resources received 80% of the royalties, but in 2011 a change was introduced under which the income became more evenly distributed among regions according to a formula that considers population indicators, unmet basic needs and employment levels. Another novelty, besides the new region-based distribution system, is a requirement that funds must be allocated to concrete programmes. Specifically, it is established by law that 10% of funds raised should go to a new Science, Technology and Innovation Fund.¹⁹ It is estimated that this STI fund will accrue an average of USD 500 million annually to invest in STI over the next few years, which represents a significant increase in the budget available for R&D (Cuervo and Lopez, 2013). Beyond R&D, funds may be used to finance a wide range of STI activities, such as training, business innovation, technological extension, purchase of machinery and equipment, etc.

The selection of projects to be financed corresponds to regional governments. Once defined and prioritised, the proposal is sent to the Technical Secretariat of the STI fund in Colciencias, which makes a first assessment of the projects to ensure they meet the basic requirements before sending them to the Collegiate Management and Decision-Making Body (OCAD). The OCAD was established in 2012 to conduct the final approval of projects, based on a set of criteria related to the quality and feasibility of the project, its social impact, alignment with national development objectives, the possibility of private sector co-funding, etc. The OCAD is composed of the following members: representatives of three national ministries and the National Planning Department (1 vote); a representative of Colciencias (1 vote); representatives from six departmental governments (1 vote); representatives from six universities (1 vote). The evaluation process includes an oral presentation of the project and a peer review of all proposals. Since the funds allocated to each region are determined in advance, regions can choose to send more or fewer projects to the evaluation process, either encouraging competition or ensuring that their priorities prevail.

This STI fund represents a great opportunity for Antioquia and Medellin, since together they make up one of the most advanced regions in the field of science and technology, and have developed an efficient institutional framework that allows them to absorb new funds and R&D projects. In 2012 and 2013 Antioquia obtained a total of COP 175,781 million (USD 90 million) from this fund, representing 14.3% of the total allocated nationally during those two years.²⁰ In addition, Antioquia was the region that achieved the highest level of co-funding (public and private) with local funds, which increased the total budget of the projects to COP 282,764 million (i.e. co-funding was equivalent to 37.8%).

But this new Fund has highlighted the risk associated with city-department dislocation, since the allocation of resources corresponds to the regional and not the municipal government. So far, though they belong to different political parties, there has been a good understanding between Medellin Mayor and the

¹⁹ For further information on the formula used for allocating royalty funds by region and type of programme, see OECD (2013), OECD Economic Surveys: Colombia 2013: Economic Assessment. http://dx.doi.org/10.1787/eco_surveys-col-2013-en

²⁰Calculations made by the authors on the basis of information published by Colciencias on: http://www.colciencias.gov.co/blog/regal-para-la-cienciatacnolog-e-innovaci-n
Governor of Antioquia and, in view of the disparity of opinions on the type of projects to be financed, it was agreed to distribute funds equally between Medellin and the rest of the department. But nothing guarantees the continuity of this agreement in the future, so Medellin risks losing funding if it fails to better align its priorities with the needs of the region. Table 4 shows the titles of the projects funded in 2012 and 2013 by the STI fund in both Medellin and Antioquia, which helps illustrate the differences between the priorities of the city and the region.
### Table 2. Projects financed by the STI fund in Medellin and the rest of Antioquia

<table>
<thead>
<tr>
<th>Projects of Medellin (selected by Ruta N)</th>
<th>Projects of the rest of Antioquia (selected by the Government of Antioquia)</th>
</tr>
</thead>
<tbody>
<tr>
<td>- Research on nanostructured solar cells: development and application of technologies in unconnected areas or with intermittent energy in the department of Antioquia.</td>
<td>- Technological, productive and commercial development of avocado in Antioquia.</td>
</tr>
<tr>
<td>- Strengthening the technological platform for specialised training in the areas of health and biomedical technology development.</td>
<td>- Technical and social research into promising oil seeds such as castor oil and sacha inchi plants with a view to their commercial development.</td>
</tr>
<tr>
<td>- Development of new therapeutic agents for the treatment of diseases considered public health priorities in Antioquia.</td>
<td>- Analysis, selection and standardisation of alternative technological systems for rehabilitation of accident black spots and performance of pilot tests in subregions of Antioquia.</td>
</tr>
<tr>
<td>- Development of STI solutions to advise the pharmaceutical and toxicological sectors in Medellin.</td>
<td>- Research into the development of productive alternatives using promising biodiverse species from the Mid-Atrato river region in Antioquia.</td>
</tr>
<tr>
<td>- Development of STI telemedicine solutions in the department of Antioquia</td>
<td>- Assessment of coal dust flammability and methane gas concentration associated to the coal bed of the underground mines in the Sinifaná coalfield.</td>
</tr>
<tr>
<td>- Development of a web platform to support a virtual centre specialised in tropical medicine.</td>
<td>- Analysis of social and economic implications of the &quot;Autopista para la prosperidad&quot; (prosperity highway) programme n west Antioquia.</td>
</tr>
<tr>
<td>- Technological platform for tele-assistance, medical emergencies, continuous patient monitoring, and for supporting promotion and prevention programmes.</td>
<td>- Promoting the growth of specialty cocoa varieties in Antioquia.</td>
</tr>
<tr>
<td>- Design of a multimedia content management and information exchange web platform specialised in biomedical imaging aimed at supporting the local health tourism strategy.</td>
<td>- Strengthening regional fisheries and fish-farming in Antioquia.</td>
</tr>
<tr>
<td>- Development of technological tools for specialised training in healthcare</td>
<td>- Strengthening the dairy supply chain in the Northern District of Antioquia.</td>
</tr>
<tr>
<td>- Development and application of nanostructured biocompatible coatings for surgical and dental instruments and implants.</td>
<td>- Development of an information and research unit dedicated to Antioquia's new educational quality standards.</td>
</tr>
<tr>
<td>- Development of an implantable cardiovertible device through the use of a carbon nanotube-reinforced textile-based nanosensor.</td>
<td>- Offering master's programmes to professors and school administrators from uncertified educational institutions from Antioquia and the west of Colombia.</td>
</tr>
<tr>
<td>- Specialised telemedicine services model for the departments of Antioquia, Choco and Cordoba.</td>
<td>- Strengthening the Antioquia Project: origin of specialty coffee varieties in the department of Antioquia.</td>
</tr>
<tr>
<td>- Design and development of a non-invasive biomedical device to measure several variables to determine oxygen levels during assessment of mitochondrial damage in critical patients.</td>
<td>- Assistance to producers in the small fruit supply chain.</td>
</tr>
<tr>
<td>- Antioquia Regional Biobank: Optimisation of the anatomical component sourcing process.</td>
<td>- Improving productivity and boosting competitiveness in the natural rubber supply chain, through an applied research innovation programme in the department of Antioquia.</td>
</tr>
<tr>
<td>- Use tropical root and tuber for production of phytosterols by biotechnological processes to obtain pharmaceuticals products.</td>
<td>- Development of architectural and technical designs for low-cost housing using concrete and rammed earth in the department of Antioquia.</td>
</tr>
<tr>
<td>- Traceability analysis in the reuse of medical devices by healthcare providers.</td>
<td>- Strengthening of the aromatic, medicinal and seasoning plants sector in the department of Antioquia.</td>
</tr>
<tr>
<td>- Development of coatings and surface texturings in the production of orthopaedic implants and surgical instruments applying nanotechnology.</td>
<td>- Research into and improvement of banana production in the Southwest and Urabá.</td>
</tr>
<tr>
<td>- Pre-hospital remote medical support.</td>
<td>- Strengthening of the vegetables supply chain in the department of Antioquia through the creation of a food</td>
</tr>
</tbody>
</table>
CHAPTER 3: INTENSIFICATION OF INVESTMENT IN R&D ACTIVITIES

INTENSIFICATION OF INVESTMENT IN R&D ACTIVITIES

PROMOTING THE DEVELOPMENT OF LOCAL INNOVATION SYSTEMS: THE CASE OF MEDELLIN, COLOMBIA

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Projects of Medellin (selected by Ruta N)

- Development of surgical implants using advanced technologies.
- Continuous home, in-hospital and ambulatory patient monitoring systems.

Projects of the rest of Antioquia (selected by the Government of Antioquia)

- Safety and waste management programme.
- Research into the achatina fulica snail pest with a view to minimising its impact on public health, agriculture and tourism, with the community of Santa Fe de Antioquia.

Note: Ruta N formally managed only 6 projects, but these were macro-projects encompassing several projects. In this table the authors opted for including a detailed breakdown of these projects.

Source: Information furnished by Ruta N and Colciencias.

Calls for research projects by Colciencias

Besides the new royalty fund for STI, every year Colciencias holds several competitive programmes to fund research projects, scholarships for doctoral degrees and internationalisation support for researchers and research groups. The 2014 call had a total budget of COP 550,593 million (equivalent to about USD 281 million), of which over 80% was devoted to further strengthening the skills of highly qualified human capital through scholarships for PhD students (for programmes in Colombia and abroad) and young researchers; and programmes for the repatriation of postdoctoral researchers. The remaining funds were used to finance research projects, innovation projects and internationalisation programmes. 21

Regarding funding of research projects, funds available in the 2014 call rose to COP 64,147 million (about USD 33 million), and were distributed by thematic areas as shown in Table 5. Note that this is a very low amount and, given the scarcity of funds, competition between research groups is very high, so in the past only around 7-8% of the projects that applied were successful (OECD, 2014).

Table 3. Distribution of the research calls for projects by Colciencias, 2014

<table>
<thead>
<tr>
<th>Description</th>
<th>Budget (USD)</th>
<th>Total Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Basic and applied research projects in the health sector</td>
<td>9,180,000</td>
<td>28.1%</td>
</tr>
<tr>
<td>Basic and applied research projects in basic science</td>
<td>8,770,573</td>
<td>26.8%</td>
</tr>
<tr>
<td>Basic and applied research projects in engineering</td>
<td>4,590,000</td>
<td>14%</td>
</tr>
<tr>
<td>Basic and applied research projects in agriculture</td>
<td>2,550,000</td>
<td>7.8%</td>
</tr>
<tr>
<td>Basic and applied research projects in life sciences</td>
<td>2,550,000</td>
<td>7.8%</td>
</tr>
<tr>
<td>Basic and applied research projects in earth sciences</td>
<td>2,550,000</td>
<td>7.8%</td>
</tr>
<tr>
<td>Basic and applied research projects in social sciences and humanities</td>
<td>2,040,000</td>
<td>6.2%</td>
</tr>
<tr>
<td>Basic and applied research projects in public administration management</td>
<td>484,436</td>
<td>1.5%</td>
</tr>
</tbody>
</table>

Total                                                                 | 32,715,009    | 100%             |

Note: Exchange rate used: 1 COP = USD 0.00051.


Regardless of the limited amount of funds available for competitive research projects, the Colombian researchers interviewed for this study often reported problems with bureaucracy and delays in the process of project evaluation and allocation of funds, although these kinds of criticisms are frequent in other countries as well. The truth is that recently Colciencias has significantly improved the quality of their calls

21 Full details of the call are available at: http://www.colciencias.gov.co/convocatorias2014/
and their internal processes in order to streamline assessment and fund allocation processes, within the framework of a technical assistance project of the World Bank.

**Internationalisation**

Considering that efforts to promote internationalisation are crucial to accelerate the development of the Colombian science and technology system, in recent years Colciencias has adopted a strategy aiming to strengthen international links. In this area the programme that absorbs most resources is the *PhD Scholarship Abroad* programme, which in the 2014 call plans to provide 400 scholarships, committing a total of approximately USD 65.3 million. This is a 100% non-refundable loan for researchers who have previously been admitted to doctoral programmes in selected overseas universities. In addition to this, the Colciencias-Fullbright Scholarship for doctoral studies in the USA, with a budget of about USD 2.5 million, offers a total of 20 scholarships, and the loan-scholarship programme Colciencias-Colfuturo, offers 1300 credits for master’s and doctoral studies abroad with a budget of approximately USD 17.5 million. Alongside these national programmes are some similar regional programmes, such as the *Enlaza Mundos* programme, created in 2008 to promote international mobility of students, professors, and researchers of Medellin.

An important novelty of the 2014 call by Colciencias was a programme called "Repatriation of brains through post-doctorates," through which 100 grants were offered to support the return of Colombian researchers abroad through postdoctoral positions in universities, technological development centres and Colombian companies, with a total budget of approximately USD 8.8 million (Source: Colciencias, 2014 Call).

Colombia has established bilateral scientific cooperation agreements with various developed countries including the United States, the United Kingdom, Spain, Germany, as well as other middle income countries such as China, India, Mexico, Chile and Argentina. The increasing participation of Colombian universities and research groups in the research framework programmes of the EU is also worth noting.

Moreover, as reflected in Table 6, in addition to scholarships addressed to PhD students, Colciencias' 2014 call also contains a number of programmes to support the internationalisation of researchers' programmes. Although the available budget is very small, it is an encouraging sign of the growing importance attributed to this line of action.
### Table 4. Colciencias Internationalisation programmes, 2014 call

<table>
<thead>
<tr>
<th>Name</th>
<th>Description</th>
<th>Budget (USD)</th>
<th>Total Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Top-ups for internationally funded projects</td>
<td>Support the development of projects with international funding between Colombian researchers living abroad and those in Colombia.</td>
<td>291,953</td>
<td>26.4%</td>
</tr>
<tr>
<td>Support for projects with North America</td>
<td>Support mobility of researchers to develop joint projects with researchers in the USA and Canada.</td>
<td>204,000</td>
<td>18.4%</td>
</tr>
<tr>
<td>Support for projects with Europe</td>
<td>Support mobility of researchers to develop joint projects with researchers in France, Germany, and UK.</td>
<td>204,000</td>
<td>18.4%</td>
</tr>
<tr>
<td>Support for projects with Latina America</td>
<td>Support mobility of researchers to develop joint projects with researchers in Brazil, Chile, Mexico and Argentina.</td>
<td>153,000</td>
<td>13.8%</td>
</tr>
<tr>
<td>Support for projects with Asia</td>
<td>Support mobility of researchers to develop joint projects with researchers in Korea, China, Japan and Singapore.</td>
<td>153,000</td>
<td>13.8%</td>
</tr>
<tr>
<td>Scholarships at Purdue University</td>
<td>Scholarships at Purdue University to conduct research for up to six months, aimed at PhD students from national universities with grants from Colciencias.</td>
<td>102,000</td>
<td>9.2%</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td></td>
<td><strong>1,107,953</strong></td>
<td><strong>100%</strong></td>
</tr>
</tbody>
</table>

Note: Exchange rate used: 1 COP = USD 0.00051.


However, in general terms, the low internationalisation of the innovation system is a weakness that should be overcome in the future. As noted by the OECD Review of Colombia's Innovation Policy (OECD, 2014), the ratio of foreign professors and researchers in Colombian universities is very low, and the ratio of foreign students in tertiary education is even lower. This national diagnosis is equally valid for the case of Medellin. Although efforts are underway to support internationalisation, the regional innovation system is still too restrictive. Therefore, it is important to boost its international openness, building on the city’s momentum and growing international reputation.

**Social innovation**

Although there are some 'islands of excellence' in Medellin in terms of companies and university research groups integrated in the global economy and operating at the cutting edge of knowledge, it should not be forgotten that the vast majority of firms in the region are not very innovative or productive, and that almost 50% of economic activity is informal. Poverty and unemployment continue to affect large numbers of the urban population, and gaps in access to education and healthcare remain a serious concern. Therefore, the challenge is to strike a balance between innovation policies aimed at strengthening and expanding these "islands of excellence", on the one hand, and the need for innovation to contribute more generally to the economic and social development of the broader population, on the other.

In other words, an inclusive kind of innovation should be promoted, which does not increase social inequalities but instead provides new opportunities and economic benefits for all citizens. For example, in recent years in various poor regions of the world a variety of ICT applications for agriculture, healthcare, education or mobile banking have appeared, which have contributed to improving the living conditions of the poorest population groups (see Box 12). Social innovation strategies seek to link the processes of
technological innovation with the attainment of social needs, such as environmental protection, social housing and associated infrastructure, and increased agricultural productivity.

<table>
<thead>
<tr>
<th>Box 12. Examples of inclusive ICT-based innovations</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>B2bpricenow, the Philippines:</strong> provides information on market prices to farmers and cooperatives, as well as an online marketplace where orders are processed via credit cards and mobile payments.</td>
</tr>
<tr>
<td><strong>M-PESA, Kenya:</strong> money transfer system by mobile phone that began in Kenya and is spreading rapidly across Africa.</td>
</tr>
<tr>
<td><strong>ReMeDi Kiosks, India:</strong> online platform aimed at helping the poor populations in rural areas diagnose diseases and respond to problems.</td>
</tr>
<tr>
<td><strong>Project Masiluleke, South Africa:</strong> helps increase the number of patients diagnosed with AIDS, and disseminates information and reminders about prevention and treatment by sending more than one million daily SMS’s.</td>
</tr>
<tr>
<td><strong>1920 Agri Extension, Sri Lanka:</strong> free hotline that provides technology advice to farmers.</td>
</tr>
<tr>
<td><strong>MIND Project, the Philippines:</strong> provides remote educational services via mobile phone. Students are evaluated and examined through the answers they send via SMS to multiple choice questions on maths and science.</td>
</tr>
<tr>
<td><strong>Child Count +, Kenya:</strong> application that collects information on pregnant women and children under five years to monitor their health and organise visits of health workers to rural regions.</td>
</tr>
<tr>
<td><strong>Hike, India:</strong> mobile messaging application like WhatsApp but which works not only with smartphones but also with previous generation phones, which are still the most widely used in countries like India.</td>
</tr>
</tbody>
</table>


Medellin is known internationally for its achievements in social innovation and its highly successful urban regeneration strategy to end violence, based on the recovery of public spaces and investment in new transportation systems to communicate the most deprived areas of the city (Metrocable, escalators, etc.). Successful programmes have been developed to find new opportunities for social inclusion of marginalised young people who were part of the drug cartels (Rodriguez and Alvarado, 2008). Such initiatives -and not so much scientific discoveries of its universities or patents- were the impetus that led Medellin to be voted Innovative City of the Year 2013 by the Wall Street Journal, the Urban Land Institute and Citigroup.

*The horizon of returns*

Investments in R&D do not generate significant results in the short term; it is necessary to ensure continuity and expansion in the medium and long-term so that the desired results are achieved. This need for continuity may be threatened by changes of government and the urgency of other policy objectives in the short term. Given the opportunity cost associated with the presence of more pressing social needs such as poverty alleviation and infrastructure development, legitimising R&D policies requires an *ex-ante* definition of the expected economic and social returns and an *ex-post* evaluation of the actual results. It is also critical to clearly link R&D policy with the economic and social development agenda.

Therefore, it is essential to continue working on the search for consensus among all stakeholders about R&D investments, articulating a convincing discourse and strategy that is not sensitive to the political cycle. Today's commitment to innovation by Medellin's government is very strong, and there is a
will to undertake ambitious projects, but nothing guarantees that things will remain that way when the current Mayor leaves office. The good relationship between the Mayor of Medellin and the Governor of Antioquia has facilitated coordination and agreement on the distribution of state funding, but this good relationship may end when the respective governments change, so it is important to work towards more sustainable agreements in the long-term.

Moreover, it should be stressed that although Medellín’s ambitions to become the Latin American leader in science and technology are fully justified, the necessary investments are large and involve many risks, while returns to society are initially intangible and will only be significant in the medium or long-term. Therefore, the deployment of the necessary investments should be made with caution, ensuring continuity over time and in any case avoiding the creation and subsequent decline of “cathedrals in the desert,” whether it is in public research institutes or intermediate institutions as technology parks and incubators. In that sense it is necessary to integrate continuous evaluation as a fundamental element of R&D policies, not only to mitigate the risks of wrong decisions but also to give visibility to the achievements, highlighting the economic and social benefits achieved.

SWOT analysis

Based on the diagnosis made in this chapter, Table 7 presents a summary of the strengths, weaknesses, opportunities and threats (SWOT) that characterise the current state of Medellín’s scientific system.

<table>
<thead>
<tr>
<th>Strengths</th>
<th>Opportunities</th>
</tr>
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<tbody>
<tr>
<td>• Presence of some of the major universities and public research centres in the country.</td>
<td>• Ability to absorb more resources from the new national research support programmes.</td>
</tr>
<tr>
<td>• Recent improvements in the articulation of the regional innovation system.</td>
<td>• Persistent commitment to social innovation.</td>
</tr>
<tr>
<td>Weaknesses</td>
<td>Threats</td>
</tr>
<tr>
<td>• Insufficient critical mass and fragmentation of research efforts.</td>
<td>• Risk of neglecting basic research.</td>
</tr>
<tr>
<td>• Dislocation between the priority research areas in Medellin and the needs of the region of Antioquia.</td>
<td>• The economic and social returns of R&amp;D require time and continuity.</td>
</tr>
<tr>
<td>• Limited internationalisation of the regional innovation system.</td>
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</tbody>
</table>

Recommendations

In line with the recent OECD Review of Colombia’s Innovation Policy (OECD, 2014), a first general recommendation, and perhaps the most important, is that Colombia should substantially increase its investment in science and technology to facilitate diversification of its economy, boost economic growth and address major societal challenges that threaten the country. Today Colombia lags far behind in R&D investment, not only in relation to OECD member countries but also in comparison with other middle and low-income countries. The recent measures to increase the budget available for science and technology such as the new royalties system are commendable, but they are still insufficient to offset the technological backwardness of the country, calling for more ambitious new measures to boost R&D spending organised around a national consensus that transcends the political cycle. At the same time, not only is it necessary to invest more, but also to do it better, through R&D investments that result in the achievement of socio-
economic objectives that become tangible in the medium term, while establishing more sophisticated monitoring and evaluation systems to enable continuous learning and a gradual improvement of public intervention.

Although Medellín can provide complementary funds and programmes this R&D agenda, intended to achieve a substantial leap in funding, must be assumed primarily from the national level. In this sense, Medellín should continue its efforts to influence the National Government’s agenda, recalling in all possible forums the need to increase political commitment to science and technology, as it has been done in recent times.22 R&D policies in Colombia are in the midst of an experimentation phase, and the National Government is receptive to any proposal from Medellín. Building upon this receptivity Medellín could exert a greater influence on the national agenda, proposing new programmes and even acting as pilot region for experimentation with new policy instruments. This more collaborative attitude should always prevail over confrontation or non-constructive criticism of national programmes and innovation policies.

While there are many current needs in the national innovation system, and in Medellín in particular, resources are scarce and efforts must concentrate on a number of priority actions. Considering the diagnosis presented above, and the results of the OECD Review on Colombia’s Innovation Policy (OECD, 2014), the following recommendations are developed further in the rest of this chapter:

- Strengthen existing research groups and encourage the emergence of centres of excellence to achieve critical mass, introducing objective and transparent evaluation criteria.
- Foster social innovation and strengthen ties between Medellín’s research agenda and the needs of the region of Antioquia.
- Improve multilevel coordination, particularly in the new royalties system, in order to exploit synergies, avoid duplication and attract more R&D funds to Medellín.
- Encourage internationalisation of the regional innovation system and attract funding, researchers, and international projects.

Both the national perspective and the regional approach are necessary for the articulation of these proposals, which are inspired by the four strategic goals presented in Chapter 1: social innovation, multilevel governance, internationalisation and smart specialisation.

**Strengthen existing research groups and support the development of centres of excellence**

As noted above, one of the main weaknesses of the regional innovation system is the fragmentation of R&D efforts and an insufficient critical mass. Although the available funds are growing substantially, they need to be shared between multiple universities and technology centres, hundreds of research groups, and a dense institutional network of intermediary organisations and public agencies. To attain better results it would be advisable to improve the governance of universities and public research institutes through clearer accountability mechanisms and allocation based on performance, introducing more competition and better incentives, while seeking a larger share of autonomous funding through competitive projects and attraction of private capital.

Recent initiatives to improve collaboration between universities are most welcome, but they are still insufficient. Beyond the collaboration between the management bodies of universities, it is important to

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22 See, for example, the article published on 31 March 2014 by deputy rectors and research directors of the G8 group of universities in Medellín at: [http://www.semana.com/educacion/articulo/inversion-ciencia-tecnologia/382220-3](http://www.semana.com/educacion/articulo/inversion-ciencia-tecnologia/382220-3)
foster greater collaboration and integration between research groups. In total there are 738 groups in Antioquia catalogued by Colciencias, with an average of less than three researchers each. Among these groups, 104 have received the highest rating (A1 or A) and could form the basis of a consultation forum with Ruta N to identify challenges and explore possible policy instruments to improve their performance. A first step is that Ruta N performs, with the information provided by Colciencias, a mapping exercise of the existing centres and develops a database with contact persons, scientific disciplines, and other defining elements of the profile and quality of research groups.

Against the current emphasis of the system on creating new institutions, new laboratories, new businesses, new technology centres, etc., we believe it is essential to build on what already exists, specifically by redoubling support for the higher quality research groups. After developing a complex institutional framework in recent years, it is time to ensure that resources reach the best research groups and are allocated to the execution of projects, purchase of equipment, and hiring of young researchers. The prioritisation of research groups is politically difficult for the governing bodies of universities, so it could be positive for an independent public agency to carry out this process, establishing transparent evaluation and selection criteria, with the participation of experts from outside the system.

At national level, one of the main recommendations of the OECD (2014) is to launch a funding programme of Centres of Excellence to promote critical mass, excellence and relevance in universities and public research institutes. Such programmes are becoming increasingly popular in the world, as evidenced by recent examples described in Box 13, which include some of the most advanced countries (such as Finland, Germany and Japan) but also other middle income (Chile) and low income (Uganda) countries.

There is also a precedent in Colombia, where Colciencias in 2007 created a programme of Centres of Excellence by which eight centres, established as consortia of research groups from different universities, were selected to develop a critical mass that allowed them to improve the quality of their research. However, in practice these centres received, between them, only about USD 4.3 million funding the first year, but public funding did not continue going forward, leaving the programme in a sort of limbo. This funding of on average USD 500,000 per centre is clearly insufficient for the envisioned objectives. A much more ambitious programme with sustainable long-term funding would be necessary.

In sum, a new programme of national Centres of Excellence, endowed with more resources and designed taking into account the system’s needs, should be considered. In this process, it would be worth exploring the possibility of obtaining funding and technical assistance from the World Bank, which has already supported other countries in the region such as Chile, Mexico and Venezuela in similar programmes through the so-called Millennium Science Initiative in collaboration with the Institute for Advanced Study.23

It would also be plausible to initiate a programme of centres of excellence from Medellin and Antioquia, oriented towards technologies and sectors to be defined under a smart specialisation strategy. The programme would support a limited number of centres of excellence, formed as alliances of the best existing research groups. For example, the programme could begin with a pilot of three centres of excellence (one for each of the current priority clusters of the city), that would receive additional funding to create links with international research centres, acquire infrastructure or technical equipment, or recruit young researchers. Alternatively, an open call, without specifying the priority areas, could be launched.

Box 13. International examples of Centres of Excellence programmes

23 For further information see: http://sig.ias.edu/msi
**Finland:** The Centres of Excellence programme initiated in 2000 selected 26 centres in different areas of research, which were awarded USD 72 million funding over a period of two years. In 2002 the programme expanded, with an additional budget of USD 43 million to 14 centres of excellence. The selected centres are formed by groups of between 20 and 200 researchers that, while sharing a research agenda and a common management team, may belong to different universities in different parts of the country.


**Japan:** In 2002 Japan launched the “21st Century Centres of Excellence Programme” to provide funding to the best research institutes and doctoral programmes at universities for a period of five years, with a total of 200 projects selected. In 2007 a new round of the programme for another five years was launched with an annual budget of around US 334 million.


**Germany:** The Excellence Initiative began in 2005 and in 2012 the second call was launched with three funding lines: one for graduate schools to promote young researchers, one for clusters that promote cutting-edge research and one for institutional strategies to promote university research. In the 2012 call the equivalent of USD 3.5 billion was allocated for a period of five years to 45 graduate schools, 43 clusters of excellence, and 11 institutional strategies.


**Chile:** Chile’s Millennium Science Initiative began in 1999 with a budget of USD 15 million for 3 years, 5 of which were financed by the World Bank. A total of eight centres of excellence were selected, consisting of research groups of one or more universities. The Programme is geared both to research and to doctoral and postdoctoral training of the best young researchers in the country. After this initial pilot phase, from 2002 onwards the programme was substantially expanded until 2012 when it reached an annual budget of around USD 18 million, funding 31 centres of excellence.

Website: [https://www.innovationpolicyplatform.org/document/research-centres-excellence-chile](https://www.innovationpolicyplatform.org/document/research-centres-excellence-chile)

**Uganda:** The centres of excellence programme in Uganda (2007-2013) emerged with the support of the World Bank, with a budget of USD 33.5 million to support 39 projects for a period of five years. Three lines of funding for centres of excellence in universities were established: the first focused on research and postgraduate training, the second aimed at creating or strengthening graduate programmes in engineering and basic science, and the third was dedicated to strengthening university-industry cooperation.


There are many possible design alternatives for centres of excellence programmes, but the ultimate goal is always to concentrate scarce resources in higher quality projects, providing additional medium to long-term funding to the best research groups so they can intensify, with some autonomy, both their research and specialised training activities. Often these programmes promote collaboration between research groups from different universities, so centres of excellence do not need to be linked to a single university, but can instead take the form of “virtual” centres. These programmes can contribute to encouraging university-industry collaboration and international linkages if they are integrated in the design of the calls. In this context it is worth noting the Centres of Excellence programmes of Singapore as a learning model that could be useful in Medellin (see Box 14).
Box 14. Singapore Centres of Excellence Programmes

In Singapore, since the creation in 2006 of the National Research Foundation (NRF), the development of research centres of excellence has received more attention. Specifically, NRF has launched two programmes: the Research Centres of Excellence (RCE) and the Campus for Research Excellence and Technological Enterprise (CREATE) programmes. First, under the RCE programme, a competitive call was launched in 2007 leading to the selection of five centres of excellence located in national universities, to develop cutting-edge research related to the strategic objectives of Singapore, all led by internationally renowned researchers recruited from foreign universities. The CREATE programme, in turn, has enabled the country to attract the R&D centres of ten prestigious international universities, including MIT, UC Berkeley and Cambridge University. This is a good example of how centres of excellence in research can be strengthened by attracting foreign researchers and institutions.

For more information see a complete description of this programme in Annex A.

Initiatives to support centres of excellence are helpful to create objective, independent and transparent resource allocation processes and to focus resources on projects of higher quality and relevance (Malkamäki et al., 2001).

International experience offers lessons on how to articulate these programmes in practice:

- For the programme to be effective, it is necessary to ensure the sustainability of funding to centres of excellence for a period of at least 5 to 10 years.

- In the design phase, it is essential to reflect about the ultimate goals of the programme, which must be clearly defined to guide the selection and subsequent evaluation of the projects.

- The selection process should be based on an assessment of compliance with a set of pre-established criteria, and it usually includes independent peer reviews, often making use of international evaluators, recognised as leaders in their scientific field.

- A programme management office should be created with a clear leadership and resources to act but, at the same time, administrative costs should be controlled.

- Programme managers should also work to disseminate the calls and provide support services to research groups in the process of preparing proposals, ensuring that the best research groups are well informed and participate in the calls.

- While it is important that the centres of excellence are autonomous, and although the returns of such programmes can only be expected to come in the medium- to long-term, it is important to establish clear monitoring and periodic evaluation to take corrective action if necessary, and to report to politicians and the civil society, so that they can take informed decisions about the continuation of these programmes.

**Encourage social innovation and strengthen ties between Medellin's research agenda and the needs of the region of Antioquia**

As noted earlier, Medellin is internationally recognised for its achievements in social innovation. Therefore, the city should continue to build on this opportunity to become an international hub of social and inclusive innovation where eventually businesses and projects for the “base of the pyramid” of Latin
America and beyond are developed. This agenda is more realistic than the ambition to become the capital of science in the region, and can be equally positive in terms of attracting businesses and talent, employment generation and, ultimately, sustainable growth.

In this context a recent promising initiative is the SocialLab project of Ruta N, which seeks to encourage public and private institutions in the city to set up laboratories for social innovation. Initially nine universities, nine social entrepreneurs and eight companies of the city participate in the programme, exchanging experiences and receiving training and support from both Ruta N and the Boston College in capacity-building for social innovation. At the first meeting of 2013, interdisciplinary teams were created around four themes: liveability, mobility, overcoming conflict and education for work, where several institutions participate, in order to coordinate projects which finally receive support from experts in social innovation of the Boston College for prototyping of social solutions.

Despite this and other interesting experiences aimed at enhancing social innovation, more resources should be devoted to these initiatives. All programmes and project evaluation processes should incorporate in a more systematic way criteria related to the social benefits of the project and the scope of expected returns. To gain the support of civil society and ensure continuity, the benefits of investment in R&D and innovation should not focus exclusively on a small group of companies and advanced research groups that defend their own interests, but should be distributed more evenly in society and also contribute to improving the quality of life of disadvantaged groups of the population. In this context, demand-side innovation policies, particularly innovative public procurement, can make a substantial contribution to more adequately articulating innovation efforts with social needs, as will be discussed further in Chapter 5.

To advance this agenda, it is essential to consolidate the close coordination between Medellín City Council and the Governorate of Antioquia. Aside from the altruistic motivations to contribute to the development of Antioquia and reduce social gaps, it would be beneficial for Medellín to redirect its research agenda to the needs of the region, seeking convergence between these and the three priority clusters of the city, or new priority research areas to be developed under a new smart specialisation strategy. In this sense, some examples of areas with high potential are:

- Using ICTs to improve the logistics systems of agricultural holdings in the region.
- New methods to improve energy efficiency in agricultural and mining activities.
- Using alternative energy sources, like solar panels, that can provide greater autonomy to rural areas sparsely connected to distribution networks.
- Processing agricultural waste to recycle it as an energy source, for example for the cultivation of coffee.
- Enhance telemedicine to provide greater coverage to the rural population of the region.
- Development of platforms and e-learning programmes by Medellín-based universities, to reach students from the rest of the region.

In addition to contributing to objectives of social and inclusive development through innovation, collaboration with the rest of Antioquia would allow Medellín to benefit to a larger extent from the new royalty fund as well as other national programmes such as the ICT Ministry’s Viva Digital, among others. For example, Antioquia is making significant efforts to integrate dispersed rural areas through the programme of Educational Parks funded by the ICT Ministry and the World Bank, which consists in the development of internet centres, schools, digital higher education, support to entrepreneurship, etc., where
universities and institutions of Medellin could play a greater role in building the necessary infrastructure and providing the content and educational programmes. A promising trend is the expansion of the universities of Medellin to other parts of the region, as illustrated by the University of Antioquia, which opened new offices in Oriente and Urabá in 2013, with infrastructure for research labs in the strategic areas of these regions.

It is also worth stressing the significant impact that companies from Medellin can have in improving the articulation between the local innovation system and the rest of the region of Antioquia, creating greater linkages not only oriented to production and distribution networks, but also to innovative activities. The R&D centres of large companies in Medellin could expand, establishing smaller units elsewhere in the rest of Antioquia, to benefit from a greater diversity of sources of knowledge, while integrating other actors currently excluded of the dynamics of innovation. A clear example is Nutresa, a Medellin-based company recognised as the largest food company in Colombia and fourth in Latin America, whose most prominent products are chocolates, pastries, cookies, coffee and ice cream, and which has intense productive activity in several areas of Antioquia. To drive innovation within the group, in 2013 Nutresa launched a venture capital fund called Out of the Box worth COP 15,000 million. By May 2014 it had already received 51 proposals and selected two which received COP 4,000 million each. It is important to reflect on how stakeholders from rural areas of Antioquia could be further integrated. In general, it would be very beneficial to achieve greater commitment from large companies in Medellin to exploit their potential flagship effect on the regional innovation system, by better integrating Medellin with the rural areas of Antioquia.

Moreover, to improve local-national coordination on issues related to social innovation, cooperation with the Department of Social Prosperity should be closer. This national Department was created in 2011 to develop and coordinate all public policies to reduce poverty and compensate victims of conflict (Schwab Foundation for Social Entrepreneurship, 2013). Likewise, the National Agency for Overcoming Extreme Poverty (ANSPE) was created in 2012 as a collaborative project between Colciencias and the National Planning Department (DNP) aimed to engage in further study of social innovation, map the national social innovation ecosystem and its main actors and interactions, and design a conceptual model of the value chain of social innovation in Colombia. One objective of this study is to lay the ground for the design of new policy instruments and an operations manual to promote social innovation.

Although interest in social innovation is increasing rapidly worldwide, the international experience available is still very limited. In fact, Colombia - in particular Medellin - is one of the countries that are developing some of the most interesting experiences that could serve as a reference for other parts of the world (OECD, 2014).

**Improve the Royalty Fund**

As explained before, the articulation and initial selection of specific projects to be financed by the fund corresponds to the governorate of each region. The regional government then sends its proposal to the Technical Secretariat of the programme in Colciencias, so that the OCAD can give final approval to projects.

The new royalties system has strengthened regional autonomy and has fostered a more systematic coordination of regional STI strategies. But early experience has revealed a number of problems in the functioning of the system (Cuervo and Lopez, 2013; OECD, 2014). One objective of the system is to promote regional convergence, and therefore a greater proportion of funds to poorer regions is intended. However, the less developed regions usually lack absorptive capacity, because they lack the necessary skills to define and implement appropriate STI projects. Collaboration between less developed regions and the most advanced is being promoted. But so far the results of this strategy have been disappointing,
because regions have not been willing to work together, as they focus on optimising projects locally, spending money on local institutions and companies, which results in fragmentation of efforts, inefficiencies and missed opportunities to generate critical mass (OECD, 2014). More broadly, the allocation of the royalty fund for STI faces the difficult challenge of combining two strategies: the first oriented to performance and scientific excellence, and the second aimed at inclusive innovation and at reducing regional gaps (Correa, 2012).

Given the problems of coordination and prioritisation between the national and the regional levels, Colciencias is working on new rules for the implementation and selection of projects financed by the royalty fund for STI, which will redefine the rules of the game (Cuervo and López, 2013). Specifically, in July 2013 Colciencias agreed to certain changes in the royalties system to define minimum requirements for programmes and projects seeking funding for STI:

- Programmes will be implemented at regional level and will focus on consolidating thematic networks that bring together different stakeholders of the university-government-industry system.
- Projects will encourage the articulation of the different levels of government: central, departmental, municipal, and promote the participation of all stakeholders.
- Projects will promote alliances between the more advanced research groups, recognised and categorised by Colciencias, and the least advanced ones, contributing to reducing knowledge gaps.

Ultimately, operation of the royalty fund poses dilemmas between centralisation and decentralisation and between the concentration of resources in the best research groups and a more balanced distribution across the country. It would be advisable to introduce further reforms in the programme to achieve a better balance between these forces that enables the best use of the funds, favouring the poorest regions but at the same time avoiding a wasteful use of resources. Below are presented a number of options and suggestions for the system’s reform.

**Recommendations for the National Government**

- Establish clearer guidelines on how to develop regional STI strategies and strengthen both the technical and financial support from Colciencias to the regional governments for the design of these strategies and formulation of projects for the royalty fund.
- Improve coordination between the STI strategies of the regions, increasing national coordinating efforts to detect duplication in regional plans, identify opportunities for cooperation, and disseminate examples of good practice that can be applied in various regions.
- Improve the current monitoring, control and evaluation system of the STI fund as well as the software for managing and monitoring project implementation to address problems related to frequent system crashes, absence of a clear point of contact for troubleshooting, poor technical support, etc. More broadly, it is important to establish more efficient and transparent mechanisms for selection, monitoring and evaluation of projects, introducing intermediate assessments and early warning mechanisms, with the possibility to withdraw funding from projects that do not meet their commitments.
- Create new mechanisms to encourage the establishment of thematic networks to promote inter-regional collaboration. For example, following a consultation process, OCAD assessments could make it compulsory to cooperate in certain cases where duplication or opportunities to exploit
CHAPTER 3: INTENSIFICATION OF INVESTMENT IN R&D ACTIVITIES | 87

synergies are identified. Another option might be to earmark a portion of the STI fund for collaborative projects between regions, with a special call for this type of project.

- Reconsider the type of projects and expenses eligible for the royalty fund. Although a detailed analysis is still lacking, the preliminary assessment of the OECD (2014) suggests that most of the funds are being allocated to training human capital. In the future, a decision to consider would be whether the royalty fund should restrict its scope to research and innovation projects, leaving training-related projects to be financed through other existing programmes.

- Establish a new mechanism so the OCAD can renew aid to projects that get the best results. Currently, projects obtain funding for a maximum period of four years, which coincides with the duration of regional development plans. This horizon may be too short, especially for ambitious research projects, and there is a risk that a change of government could result in successful projects coming from the previous government being disregarded. Therefore, it would be interesting to introduce a system for extending aid more automatically, without first having to go through the departmental government. In any case, renewals should be restricted to only the best projects so that the new governor does not get a fully committed budget.

- A more radical reform to avoid the risks of excessive decentralisation of the selection process would entail establishing a more centralised evaluation mechanism by Colciencias. The funds could continue to be allocated to the different departments, but for the selection of the projects within each department, Colciencias would launch an open call and evaluate the proposals. Each departmental government would establish its priorities and participate in the design of the call, but the management and final selection of projects would correspond to Colciencias, using external evaluators and other procedures to ensure independence.

**Recommendations for Medellin and Antioquia**

- Establish a clearer and more stable system for the co-participation of Medellin City Council and the Governorate of Antioquia in the articulation and selection of projects. As it was noted earlier, although the management of royalty funds corresponds to departmental government and not to the municipal government, Ruta N has also played an important role in project selection. By an agreement between the Mayor of Medellin and the Governor of Antioquia, it was decided to allocate 50% of the royalty fund to Medellin and 50% to the rest of the region. However, there is no guarantee that this system will continue in the future. It would be desirable to clarify the institutional framework that will apply in the years ahead.

- Build more transparent and competitive criteria for project selection. So far the project selection process has been somewhat chaotic, which is natural considering the recent birth of the royalty fund. However, in the future more efforts will be needed to better define both the substance and the form of successive calls and selection criteria.

- Establish mechanisms that allow certain strategic projects to maintain their funding in the longer term, introducing the possibility of quasi-automatic renewals of funding if the required milestones are achieved. In this way, projects would not be affected by changes of government.

- Given the changes underway in the royalties system, it is essential to consider potential collaborative projects with other regions. This agenda would be based on the search for areas of convergence between Medellin's strategic research priorities and the needs of the country's most disadvantaged regions, from a social innovation perspective. An example of how such convergence can be successfully achieved was given in 2012 by the company UNE (a telecom in
the EPM group) and a number of local partners, who joined forces and managed to obtain funding from the royalties system for a project aimed at providing telemedicine services thereby increasing the quality and coverage of health services and promoting disease prevention in the regions of Antioquia, Chocó and Cordoba.

**Promote internationalisation**

If Medellin wants to achieve its goal of becoming Latin America's innovation capital, it is essential to promote internationalisation and seek new strategies to attract talent and international funding, and to strengthen international scientific cooperation.

Efforts to promote the internationalisation of the research and innovation system in Colombia, as noted above, have focused on offering scholarships for local students pursuing their doctoral studies abroad, and such programmes take most of the budget of the international programmes of Colciencias. The fact that many of the professors and researchers completed their doctoral studies abroad means that international scientific ties are strong and mechanisms to strengthen them further in the future should be sought.

Investment for building national talent in foreign universities is important as a mechanism for accelerating technological convergence and should be further enhanced in the future. But at the same time, an effort in the opposite direction would be desirable, i.e. attracting foreign researchers to local universities. In this context, a first set of recommendations are proposed. Secondly, some possible lines of action are suggested to strengthen collaboration with universities and research centres abroad.

**Attracting foreign researchers**

Colombia in general and Medellin in particular should devote greater efforts to stimulate the arrival of foreign researchers, particularly from other Latin American countries, who could contribute to the development of local capacities in strategic areas as well as the formation of links with international research centres. These programmes should establish mechanisms to reduce administrative barriers and avoid inbreeding, facilitating access of foreigners to the university system, offering them information, advice, scholarships and special contracts. The attraction of talent could be articulated through centres of excellence programmes, as it was done in the case of Singapore described in the previous section (see Box 14). The aim would be to attract world-class researchers to direct (or co-direct) the new centres of excellence to be created in Colombia or Medellin.

An important success factor for programmes to attract talent consists in undertaking an active search for foreign researchers that best fit local needs, and establishing personal contact with them to understand their needs and "seduce" them with adequate incentives. In other words, this entails a more personalised approach to talent attraction programmes, such that efforts are not limited to publishing calls. Another interesting element would be to focus efforts on attracting researchers from Spanish-speaking countries, both in Latin America and Spain (where there is a significant base of well-trained researchers who are willing to migrate due to the current lack of opportunities in that country), which may be a more appropriate target than attracting people from other third countries, taking into account local characteristics and the objective of transforming Medellin into the Latin American capital of innovation.

From a multilevel governance perspective, it should be considered whether programmes to attract talent make sense from the regional/local level or whether these should be addressed solely through national level programmes. The case of Spain is useful to support the first argument, since Spanish national and regional programmes to attract talent coexist. Indeed, Spain has developed some national programmes, especially oriented to the return of Spanish researchers working in foreign centres, but simultaneously...
some regions of the country have decided to launch specific programmes to attract talent, both from other Spanish regions and third countries (see Box 15).

### Box 15. Regional programmes to attract talent in Spain

Some Spanish regions have created agencies to attract talent in order to circumvent the regulatory and institutional problems hindering recruitment of foreign researchers. These agencies, through annual open calls, offer special contracts for researchers from foreign countries or the rest of Spain to join public universities or local research centres, circumventing the rules on the recognition of qualifications and bureaucratic processes for the accreditation of university professors. Through these programmes it becomes possible to compete for international talent, offering more attractive salaries and dodging the usual inbreeding of universities and the favouritism for local candidates at the expense of scientific excellence.

Catalonia region was the pioneer in this type of programme in Spain, with the establishment of the Icrea programme in 2001. In its twelve years up until 2013, Icrea has hired a total of 294 researchers in a variety of disciplines, who have contributed decisively to the development of regional scientific skills, and particularly to the increase in scientific publications and patents, as well as to attracting funding from European and national competitive programmes, as evidenced by an independent evaluation of the programme conducted recently by Technopolis.

Following the successful example of Icrea, in 2007 the Basque regional government launched a similar programme called Ikerbasque, which until 2012 attracted 116 researchers from 20 countries. Both Ikerbasque and Icrea are directed not only to foreign researchers but also to the rest of Spain. For example, 31 of the 116 Ikerbasque researchers came from other Spanish regions, 55 from other EU countries, 20 from the USA and 15 from other countries. Initially, the Ikerbasque programme offered permanent contracts only to senior researchers, but in 2012 it also included a specific call addressed to young researchers with a promising scientific career and international experience, who were offered 5-year contracts. As in the case of Icrea, recent assessments of Ikerbasque are very positive: for example, the researchers employed by Ikerbasque achieved more than EUR 17 million of external funding for research projects, which represents almost twice the investment made to attract them.


Alongside, it would be important to devote a special effort to facilitate the return of Colombian researchers working abroad. A useful tool to achieve this are linkage programmes, which have been used in different ways by many countries to promote networking between researchers from the Diaspora, aimed at transferring knowledge and technology skills, and to create business networks and opportunities for local investment (OECD, 2012b). As noted above, Colciencias has launched a new call that should be expanded and improved in the future, not only to encourage the return of scientists to the country but also to strengthen scientific collaboration, the exchange of knowledge and the involvement of the Diaspora in the processes of evaluation of the Colombian science, technology and innovation system. Medellin should reflect on how to get more out of this initiative of Colciencias and how to supplement it with other autonomous initiatives. An example is the Ruta N's "Student Exchange" programme, designed to link students at public universities with Colombian PhD students studying abroad in the development of joint projects. This programme is expected to be launched shortly through the development of a web platform that allows these interactions.

**International collaboration with universities**

Beyond initiatives to attract talent, it would be advisable to assess potential measures to improve the mechanisms for collaboration with foreign universities. At the national level there is a working group driven by Colciencias, called International Group, which aims to identify opportunities for international cooperation in science and technology, providing the country’s research groups and centres access to international intellectual and financial resources. Additionally, the Ministry of Education has promoted the
Colombian Network for the Internationalisation of Higher Education which aims to promote internationalisation through the exchange of best practices between universities and through the organisation of different events. Also the National Academic Network of Advanced Technology (RENATA), driven by the National Government and composed by more than 150 universities and R&D centres in the country, aims to foster collaboration with the most developed international academic networks and research centres of the world.\textsuperscript{24, 25} Moreover, Colciencias has acted as a National Contact Point to encourage the participation of Colombian research groups in the research programmes of the European Union, and the new Horizon 2020 programme, launched in late 2013, opens more opportunities for the participation of Colombian research groups in projects and networks financed with European funds.\textsuperscript{26}

Medellin should be attentive to the activities of these national initiatives. It would be advisable to further integrate international scientific collaboration into the agendas of the Cooperation and Investment Agency of Medellin (ACI) and Ruta N. A programme for regional centres of excellence, with a more selective framework and more resources, would encourage the insertion of the best research groups of the city in global innovation networks. Indeed, as evidenced by Giuliani and Rabellotti (2012), rather than having generic measures and framework agreements between universities, the most efficient way to enhance international connections of local universities is to support the best researchers and research groups, as they are the primarily responsible for the transfer of knowledge. These researchers act as bridges to international networks, and are characterised by their talent, knowledge of languages, and publication record in top scientific journals.

On the other hand, incentives to attract the R&D centres of foreign universities and companies could be improved. The Medellinovation district in the Medellin municipality and the Manantiales Technology Park in Antioquia offer excellent platforms to provide incentives to foreign companies and institutions. Chapter 6 addresses the policy options to attract innovative foreign companies to the city, which currently represents a priority objective of Ruta N. In this regard, there is a need to seek new ways of attracting foreign universities that can implement research centres and advanced training in the city; an increasingly popular trend among large global universities that calls for active public intervention and an offer of generous incentives. A noteworthy example is the Georgia Institute of Technology, one of the most recognised American research universities, which in recent years has established new R&D centres in Latin American countries like Costa Rica, Mexico and Panama, in addition to its other centres outside the USA which include France, China, Ireland and Singapore.

In fact, Purdue University is a successful example in this regard both in Colombia and Medellin. Since 2010 Colciencias has had an agreement with this US University for the exchange of students and professors, and in January 2014 the university announced its intention to establish its first liaison office in Medellin, within the facilities of Ruta N.\textsuperscript{27} In 2011 Purdue University had donated a supercomputer to EAFIT University of Medellin, and this latest announcement marks a new commitment to strengthen ties with the city.

Singapore’s experience described above (see Box 14) is a very interesting learning model for Medellin. Also, the International Centres of Excellence programme in Chile is an interesting experience to consider. Through the first call of this programme, the Chilean government offered foreign universities and

\textsuperscript{24} Further information at: http://rcicolombia.jimdo.com/
\textsuperscript{25} Further information at: http://www.renata.edu.co/
\textsuperscript{26} Further information at:
\textsuperscript{27} Further information at: http://www.portafolio.co/economia/alianza-u-purdue-y-colciencias
public R&D centres a maximum grant of USD 12.8 million over a period of eight years, to be complemented with self-financing from their own institutions. Thus, in 2011 four international institutions devoted to the development of research programmes in areas linked to the country’s priorities were selected: the German Fraunhofer in biotechnology; Australian CSIRO in mining; French Inria in information technology; and Dutch Wageningen in the food industry. 28

In conclusion, incentives and programmes to attract talent and foreign universities represent a powerful mechanism to accelerate the internationalisation of the system and promote international technology transfer and dissemination of knowledge and technology. However, they also represent a risk and an opportunity cost, since those resources could be used instead to support local universities and researchers. Therefore, these programmes should be designed with the greatest caution, establishing evaluation mechanisms to ensure that the social returns obtained justify their high costs.

Other recommendations

- **Guide the city’s research agenda towards a smart specialisation strategy.** Smart specialisation implies greater concentration of scarce resources in a set of clearly articulated priority areas according to the strengths and comparative advantages of the city. The current approach of targeting priority industrial clusters should be complemented with a commitment to a set of key enabling technologies that are relevant to various industries simultaneously. This requires the development of platforms for collaboration between government, universities and industry, as discussed in greater detail in Chapter 4.

- **Explore opportunities for mergers or collaborations between different graduate programmes in related fields.** As noted earlier, Medellin’s universities have a total of 47 doctoral programmes, as well as hundreds of master's programmes, which sometimes remain active without a sufficient number of students. It would therefore be advisable to encourage new inter-university and interdisciplinary programmes that help avoid these duplications and achieve greater economies of scale to boost the quality of the programmes. In the short term, a priority would be to launch a doctoral degree in engineering taught by the best research groups from different universities of Medellin, with different areas of expertise, which has the potential to emerge as the best engineering doctoral programme in the country and a reference in Latin America, capable of attracting a high proportion of foreign students.

- **Strengthen the work of Tecnova in the promotion of technology transfer and commercialisation of university research results.** As noted earlier, Tecnova was created as a partnership between the leading universities in the region to strengthen their technology transfer offices, allowing economies of scale, sharing of best practices, and the implementation of cross-cutting programmes to improve university-industry relations and promote technology transfer and commercialisation. Their work has helped overcome the constraints of existing technology transfer offices, which often lacked the human resources, expertise and experience necessary to undertake their work effectively. In recent years some universities in other regions have joined Tecnova, including the University of the Andes and Uninorte Atlantic University, among others, demonstrating the success of this model and the potential to eventually transform Tecnova into a state agency. Indeed, the National Government could consider new ways to support Tecnova and expand its scope to the whole country.

- **Find new ways to complement Colciencias’ programmes with local initiatives.** For example, additional local funding could be offered to research groups that have obtained aid from the

28 For further information, see Learning Model in Annex A of this Review.
competitive programmes of Colciencias, if they meet some additional requirements such as addressing a research area that is considered a priority for the city. In this way, there would not be a need for new assessments in the process, reducing the cost of administration of incentives. Moreover, these initiatives contribute to the objective of concentrating more resources in the best research groups to achieve greater critical mass and prevent fragmentation. The type of eligible costs that could be covered by this additional aid should be clearly determined. For example, the additional resources could be allocated to the recruitment of young doctors who are integrated into the project, or to the recruitment of distinguished foreign researchers. The same could be done for doctoral students receiving doctoral scholarships from Colciencias: Medellin could top up such support to, for example, those doctoral students who develop their research in one of the three priority clusters, or in a number of selected research groups (for example, those classified as higher quality groups by Colciencias). This could also encourage the best doctoral students who obtain a grant from Colciencias to choose to study at a university in Medellin.

- **Beyond Colciencias programmes, explore how Medellin could participate to a larger extent in R&D activities funded by other ministries and national agencies.** In particular, taking into account Medellin's priority clusters, a priority would be to strengthen collaboration with the Ministries of ICT, Mining and Energy, and Health and Social Protection, without forgetting other relevant ministries such as Education, Defence, and Transport. A successful example is the case of Vivelab, a national network driven by the ICT Ministry to promote business based on digital content, video, animation, graphic design, mobile applications, etc. Recently an agreement was concluded between this programme and Medellin City Council to create a Vivelab centre in Ruta N's main facility, which is already operating and has 30 workstations.

- **Further integrate the promotion of R&D with the international development cooperation agenda.** In recent years, international organisations such as the Inter-American Development Bank and the World Bank, and national governments and NGOs, have been focusing more of their aid and technical assistance to programmes aimed at strengthening national innovation systems in developing countries (Machado, 2013). In the case of Colombia, Colciencias recently received a USD 50 million loan from the World Bank. Another example is the Spanish government's ERICA programme for Antioquia, which has among its goals the promotion of technological development and innovation in the region. Such initiatives could be expanded in the future to leverage the funds available for STI.
References


CHAPTER 4
PROMOTING BUSINESS INNOVATION, SUPPORT FOR ENTREPRENEURS AND PARTICIPATION OF STRATEGIC ACTORS IN STI ACTIVITIES

The recent OECD Review of Colombia's Innovation Policy (OECD, 2014) notes that, despite the good performance of the Colombian economy during the last decade in terms of economic growth, expansion of exports and substantial social progress, there remains a significant lag in the country's performance in science, technology and innovation, with a business and entrepreneurial sector that plays a rather peripheral role in the national innovation system.

The Review highlights the key role that should be assigned to innovation in its many forms to address the challenges faced by Colombia in terms of transforming and diversifying the economy, boosting productivity, increasing income and employment levels of the growing urban population, promoting agricultural diversification to improve the quality of life in rural areas, and ensuring the environmental sustainability of growth.

The OECD's Review also points out the strategic need to put the business sector at the heart of the innovation system, as in the more advanced economies and the more successful emerging economies. Companies are the main source of dynamism in all high-performing innovation systems, and help enhance applied scientific research and advanced human capital training activities, of universities and research institutes. Currently business participation in activities and programmes related to innovation in Colombia is low, as only 30% of the total R&D activity is performed by the business sector, compared with 65 to 75% in more advanced OECD member countries and China, and just under 50% in Brazil (OECD, 2014).

The international literature indicates that the likelihood that a company may engage in activities and investments in STI may vary depending on the productive segment it operates in; its size, sector and age; and the origin of its capital; but especially on the sophistication of the demand for its products or services and its ability to identify opportunities in the markets in which it competes (OECD, 2010). That is why local initiatives such as Medellín Ciudad Cluster launched by the Chamber of Commerce, or the Landing programme for international companies led by Ruta N and supported by the Cooperation and Investment Agency of Medellin (ACI), pay particular attention to specific sectors of high competitive potential, as well as initiatives that promote dynamic innovative entrepreneurship and the settlement in the area of foreign technology-based companies with an innovative profile. What makes such actions relevant is their potential to exert a catalytic effect on the participation of local businesses in STI-related investment.

Policies to promote business innovation in Colombia are directed mainly to companies driven by science and research, and to developing links between universities and the productive sector (OECD, 2014). Important as this is, the growth potential of innovation does not only correspond to that segment of firms or to applied scientific research. Furthermore, special mention should be made of the group of multilatinas based in Medellin, which in recent years have expanded their R&D activities, and to the foreign companies that have created new R&D centres in the city.

29 Table 10 in this Chapter provides further detail on some specific initiatives in this respect.
However, such initiatives tend to be the exception rather than the rule. Several studies have identified relatively weak interactions between the different stakeholders in the Colombian innovation system.

Moreover, environmental conditions, such as the macroeconomic and business environment, and the effectiveness (or lack thereof) of the regulatory intellectual property framework play an important role in the companies’ decision to invest in STI. STI investments require a medium-term horizon to be profitable, so a reasonably stable and predictable economic environment is crucial to the success of policies aimed at promoting business innovation.

An examination of the performance of funding for business projects in STI in Colombia reveals poor coordination between the institutions responsible, with a tendency to duplication and fragmentation of efforts and limited impact of each individual instrument (calls for projects, etc.) given the fact that resources available to be transferred are usually quite limited. This situation is common not only in Latin America but also in many OECD member countries.

An important national milestone in public policy was the creation in 2012 of Innpulsa, a platform created by Bancoldex with a view to promoting business innovation and dynamic entrepreneurship as triggers for the competitiveness and regional development of the country. The strategic objectives defined for Innpulsa are: (i) building and strengthening a mindset and a culture that encourage innovation and dynamic entrepreneurship; (ii) strengthening the ecosystem to provide dynamic entrepreneurs and innovative companies with new funding vehicles that make them more competitive; and (iii) developing and strengthening the capacities of the region with an emphasis on productivity.

Public instruments available to support business investment in STI in Medellin are very schematically presented in Table 8. It can be seen that different public institutions, such as Colciencias, Innpulsa, and the Ministries of Agriculture (MINAG), Trade, Industry and Tourism (MINCIT) and Information and Communication Technologies (MinTIC), among others, and the Collegiate Management and Decision-Making Body (OCAD) within the national royalties system framework, manage a large number of instruments and calls plagued with design, implementation and coordination issues that often result in excessive red tape during the application and execution phases, slow responsiveness, and lack of continuity (Bitran et al, 2011).

It is worth noting that the RII s recently introduced by Ruta N (referred to in Table 8), which are the result of a coordination effort by key stakeholders around a shared goal, can go a long way towards counteracting many of the problems brought about by the fragmentation of instruments and institutional channels. The Finnish TEKES agency also has similar programmes. It must be said, however, that despite the difficulties involved, most universities and R&D centres regularly resort to the available mechanisms. Nonetheless, this is not the case at the private enterprise level, where only firms with greater sophistication seem familiar with some of the public support tools for STI.

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30 The Colombian Bank of Foreign Trade (BANCOLDEX) is a second tier public financial institution, adscrite to the Ministry of Commerce, Industry and Trade.

31 To date, Finnish Agency TEKES has led about 30 integrated innovation programmes on diverse priority areas, with a view to achieving a challenging and global market expansion. Further detail at: http://www.tekes.fi/en/programmes-and-services/tekes-programmes.

32 In fact, the co-funding instrument for collaborative R&D projects between universities, R&D centres and businesses has been favourably evaluated in a comparative analysis that included similar funding instruments in countries such as Mexico, Chile, etc. (Inter-American Development Bank, IDB, 2011).

33 See OCyT (2012). A more detailed though less up-to-date analysis can be found in Salazar et al. (2007)
Table 6. Main public instruments to support business investment in STI

<table>
<thead>
<tr>
<th>Offering Institutions</th>
<th>Programmes or Instruments</th>
<th>Methodology</th>
<th>Classification of Users</th>
</tr>
</thead>
</table>
| COLCIENCIAS           | 1. Co-funding of projects between universities, R&D centres and groups, and enterprises.  
                        | 2. Seed capital for STI-based start-ups.  
                        | 3. Funding of patents or protectable technologies.  
                        | 4. Incorporation of PhDs to work in R&D activities in companies.  
                        | 5. Deduction on income tax for STI-related work. | Through annual or biannual calls. | Mainly universities, but also companies with development and innovation units. |
| INNPULSA              | 1. Support for innovation and quality improvement projects in micro and small enterprises (formerly Fomipyme programme).  
                        | 2. Support for start ups.  
                        | 3. Support to the Rutas Competitivas Programme, which aims at developing two regional clusters in each of the participating departments  
                        | 4. Support for innovation management in companies. | Through periodical calls. | Companies, start-ups, business groups or chambers of commerce. |
| SENA                  | 1. Innovation and technological development programme. Funds under Law 344. | Through periodical calls | SMEs, local liaison and technology transfer local bodies. |
| General Royalties     | 1. STI fund. | Annual call: Colciencias acts as Technical Secretariat of the OCAD. | Unrestricted, but preferably universities and R&D centres. |
| Ruta N                | 1. R1s  
                        | 2. Inngenio Call.  
                        | 3. Seed capital grants.  
                        | 4. Innovation management strengthening programme (in partnership with Ideé Laboratoriet, Sweden).  
                        | 5. Start-Up Weekend. | 1) Joint triple helix initiatives led by Ruta N;  
                        | | | 5) Local calls for projects. | Users 1: groups of actors from university, industry and government led by the Medellin's STI Plan  
                        | | | Users 2: actors from MSMEs, large companies and institutions (universities and research and technological development centres)  
                        | | | Users 3 and 5 young companies and start-ups.  
                        | | | Users 4 medium and large |
### Medellin and Antioquia Chamber of Commerce

Medellin ciudad cluster initiative (in partnership with the City Council). It aims to strengthen and facilitate access to markets by companies belonging to member clusters: (i) textile - production, design and fashion; (ii) construction; (iii) electricity; (iv) medical and dental services; (v) information and communication technologies; and (vi) corporate travel, fairs and conventions.

- **Offering Institutions**: Medellin and Antioquia Chamber of Commerce
- **Programmes or Instruments**: Medellin ciudad cluster initiative (in partnership with the City Council).
- **Methodology**: Permanent programme operates through annual work plans for each cluster.
- **Classification of Users**: Local companies in relevant sectors. Companies may be in the start-up, stabilisation, growth or consolidation phases.

### National Council for Tax Benefits (CNBT)

- **1) Tax deduction on R&D activities.**
- **2) Tax deduction on donations to R&D activities.**
- **3) VAT deduction on imports of research-related goods.**
- **4) Exemption from income tax for innovations in software, medicinal products; R&D projects and researchers.**

- **Offering Institutions**: National Council for Tax Benefits (CNBT)
- **Programmes or Instruments**: Permanent programme operates through annual work plans.
- **Methodology**: Open window, annual statements. Benefits 1, 2 and 3 must be validated by Colciencias.
- **Classification of Users**: Enterprises, universities, R&D centres.

### Medellin City Council

- **1) Five-year tax cuts for firms operating in certain economic activities within the clusters, developing specified innovations.**

- **Offering Institutions**: Medellin City Council
- **Programmes or Instruments**: Annual agreements.
- **Methodology**: Annual validity, 5 years, with deductions decreasing over the validity period.
- **Classification of Users**: Existing firms or companies established within five years from the entry into force of the agreement.

### Medellin City Council

- **1) Parque E start-up accompanying programme.**
- **2) Companies’ Acceleration Programme by CREAME Business Incubator.**

- **Offering Institutions**: Medellin City Council
- **Programmes or Instruments**: Annual agreements.
- **Methodology**: Entrepreneurs, start-ups and growing businesses.

Source: Prepared by the authors on the basis of: Vargas, Leyva, et.al. (2013), web sites, information provided by Ruta N and corporate advertising material of the different institutions mentioned.

Medellin’s local STI system has reached a higher level of development and visibility than other cities in Colombia, even the ones of greater relative size. At the same time, the strategy of promoting clusters implemented further to the publication of the *Monitor Medellin Report* (1994) under the aegis of the local Chamber of Commerce, in partnership with Medellin City Council, remained in force until the present, with some changes in its priorities resulting from its two-decade evolution.

An important input for updating the aforementioned cluster-based tactical selectivity strategy has been Medellin’s STI Plan which, in the sections devoted to business innovation, pledges to pursue the following strategic priorities: (i) definition of strategies, policies and programmes for creating and advancing technology-based firms in Medellin and the region; (ii) direct support to Medellin’s technology-intensive industry; (iii) strengthening of Medellin’s technology-driven clusters; and (iv) greater inter-enterprise collaboration and strategic partnerships for the internationalisation of technology-driven clusters.
Against these priorities, and based on an examination of the six clusters included in the current strategy, the STI Plan urged that the three clusters with the greatest potential for internationalisation should be devoted greater attention. Specifically, these clusters should develop new business based on dynamic competitive advantages such as expert knowledge and innovation capabilities.

Table 7. New types of business under the Medellin Ciudad Cluster programme

<table>
<thead>
<tr>
<th>Cluster</th>
<th>New business areas with high dynamic potential</th>
</tr>
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<tbody>
<tr>
<td>Energy</td>
<td>• Engineering services;</td>
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<tr>
<td></td>
<td>• Smart grids; and</td>
</tr>
<tr>
<td></td>
<td>• Energy eco-efficiency.</td>
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<tr>
<td></td>
<td>• Development of technological platforms;</td>
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<tr>
<td></td>
<td>• Smart Networks; and</td>
</tr>
<tr>
<td></td>
<td>• Generation of animation and digital content.</td>
</tr>
<tr>
<td>Health</td>
<td>• Development of e-health platforms; and</td>
</tr>
<tr>
<td></td>
<td>• Internationalisation of the health supply chain.</td>
</tr>
</tbody>
</table>


To follow up the fulfilment of these strategic commitments, the STI Plan contemplates the implementation of strategic monitoring mechanisms, and the identification of "co-discovery" opportunities based on the development of roadmaps and the articulation of multilevel governance mechanisms between national, departmental and municipal institutions. In line with this effort, Ruta N is implementing a platform of performance indicators based on a comprehensive mapping of all projects, with a view to facilitating institutional work and establishing effective multilevel coordination models.

The Plan, presented during the second half of 2011, involves two implementation phases. The initial phase, which covers the consolidation of the strategic plan during the period 2011-2015, focuses on the first and second strategic priorities, which aim at strengthening the coordination and operation of the regional innovation system while promoting access to national and international funding streams that may lead to increased investments in STI. The second phase contemplates the expansion of the regional innovation system between 2016 and 2021 and tackles the deployment of the system, which is what the third and fourth strategic priorities aim at.

As indicated in Chapter 1, the STI Plan comprises multiple objectives and specific instruments, currently at various stages of development or implementation. The consolidation stage comprises two approaches: (i) on the one hand, the Plan will serve as a guide for Ruta N and the STI ecosystem, which includes all organisations that make up the regional innovation system; (ii) on the other hand, Ruta N shall be responsible for implementing the plan, which involves managing the budget allocated by Medellin City Council through the action programmes referred to in Chapter 1. The paragraphs below contain a description of the most significant trends in Medellin's regional innovation system in terms of knowledge supply, applied R&D, and business-driven demand for STI. While not exhaustive, this analysis identifies the main challenges and opportunities faced by Medellin to achieve significantly higher rates of business investment in STI.
Encouragement and coordination of business-driven demand for STI

The number of companies formally registered in Medellin stands at 90,320 (2012), of which 97% are micro and small and only 1% are large enterprises. In spite of the dearth of detailed information, the latest national innovation surveys, conducted by the manufacturing and service sectors, were used by the Colombian Observatory of Science and Technology (OCyT) to estimate that in 2012 firms would contribute 26% of total spending on STI activities in the department. This percentage is lower than the national average for the same year. The same source states that in 2012 large companies in Colombia, defined as those with more than 200 employees, were the largest contributors of human and financial resources to STI activities.

Medellin is home to at least eight large corporate groups, which have consistently shown significant growth rates, recognised leadership at country level and a significant export potential in non-traditional areas. Some of the most important groups are: Empresas Públicas de Medellín (EPM), Interconexión Eléctrica, SA (ISA), Almacenes Éxito’s retail outlets, Grupo Argos, Grupo Nutresa, Grupo Corona, Grupo de Inversiones Suramericana (SURA) and Grupo de Manufacturas Orbis (formerly Grupo Mundial). The first five feature among the 15 largest companies in the country. The stock market capitalisation of Medellin-based companies was higher than that of companies headquartered in Bogota (excluding Ecopetrol).

Empresas Públicas de Medellín (EPM) is a public company in the energy, water and telecommunications sectors. Besides Colombia, the company has expanded in recent years to countries in Central America, Mexico and Chile. It is especially known internationally for its leadership in the construction and management of hydropower plants.

ISA is a state-owned conglomerate that actively participates in the energy and telecommunications sectors in Latin America. It is dedicated to the transmission of electricity with a high-voltage network of about 39,000 km, deployed in Colombia, Peru, Bolivia and Brazil, and interconnections between Venezuela, Colombia, Ecuador and Peru.

Argos is one of the leading cement producers in Colombia, which is also the third largest cement producer in the United States. It also has a strong presence in Central America and the Caribbean.

Sura has been the fastest growing financial group in recent years in the country, with a strong presence in several Latin American countries.

Nutresa is the largest food company in Colombia and fourth in Latin America, with presence in most of the Americas and Malaysia. Its best known products are chocolates, pastries, cookies, coffee and ice cream.

The Corona and Sumicol group is dedicated to building materials, tiles, chemicals and paints, and also has a significant presence throughout the Americas.

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34 Source: Chamber of Commerce of Medellin.
35 This concept significantly exceeds the R&D expenditure for each year. It includes, innovative activities in a broad sense, and administrative and support costs, among others. The most recent available data come from both the Development and Technological Innovation in Manufacturing Survey (EDIT) for 2009-2010, and the Development and Technological Innovation in Services Survey (EDITS) for 2010-2011. These surveys were administered by the National Bureau of Statistics, DANE.
36 Ruta N’s presentation ¿Por qué invertir en Medellín? (“Why invest in Medellin?”), 2013.
During the last decade, the local corporate segment has significantly increased its R&D activities in the city. In this context, the EPM group deserves a special mention as in recent years it has allocated 0.6% of its revenue to R&D and from 2012 has been bound by law to devote 7% of its regular profit to the implementation of Medellin’s STI plan. Furthermore, in March 2013 EPM set up a private equity fund with COP 100,000 million to be invested in new businesses and innovative projects relevant to the firm’s business lines.

At the same time, as their commitment to R&D grows, these big companies are strengthening links with local universities. A clear indication of this is the recently inaugurated Argos Centre for Innovation (ICSC), created in association with EAFIT University to promote research into cement production. Another example is the partnership formed in 2013 between Sumicol and the University of Antioquia, oriented to research into microencapsulation and non-metallic-mineral based nanosystems.

Also some foreign multinationals have established R&D centres in the city in the last few years. The most prominent examples are provided by Hewlett-Packard and Kimberley Clark. HP Labs (Hewlett-Packard) opened its doors in Medellin in 2010, initially settling in the EAFIT campus, and then moving to Ruta N’s modern building in the city. In addition to providing high technology services to local companies, HP has undertaken innovative projects and increased its investment in local R&D activities. As regards Kimberley Clark, in 2012 it established its Global Innovation Centre near Medellin, which joined the ones the company already had in the United States and Korea, with an initial investment of USD 20 million.

Looking towards the future, the challenge is to make sure that the large Colombian companies mentioned above continue focusing their R&D activities in the city and, at the same time, keep encouraging foreign companies to bring their R&D activities to Medellin. The rapid international expansion of the multilatinas based in Medellin can act as a lever to stimulate the local innovation system, provided that the necessary scientific and technological capabilities are developed in the region to meet increasingly demanding business requirements.

The following table shows some significant data on investment in STI as well as some outstanding initiatives related to innovative initiatives by four corporate groups in the city of Medellin: EPM, Argos, Nutresa and Corona.
### Table 8. STI investment initiatives by Medellin-based corporations

<table>
<thead>
<tr>
<th>Business Group</th>
<th>Sectors and technologies of interest</th>
<th>STI investments (2012) and leading initiatives</th>
</tr>
</thead>
<tbody>
<tr>
<td>EPM</td>
<td>Energy, water, nanotechnology, ICT, innovation management, new business.</td>
<td>USD 22.7 million (including Ruta N's contribution of USD 14.9 million). Contribution of USD 55 million for the creation of the &quot;Entrepreneurship and Innovation SP&quot; venture capital fund for new businesses.</td>
</tr>
<tr>
<td>Argos</td>
<td>Cement, chemicals, new business.</td>
<td>USD 9.6 million. The group has a Vice Presidency for innovation, responsible for: innovation management, research and development, and new business. Plans are underway to develop an STI centre on the EAFIT University campus. Argos was one of the winners of a programme co-sponsored by Ruta N and Medellin City Council to strengthen the innovation management system. Together with Swedish company Idé Laboratoriet and companies like Exxon Mobil, 3M, GE Energy, IDEO and Johnson &amp; Johnson, Argos was invited to present the Ideaixon system at the Back End of Innovation (BEI) conference.</td>
</tr>
<tr>
<td>Nutresa</td>
<td>Food, biotechnology.</td>
<td>USD 5.8 million. In 2012 Nutresa launched an open innovation programme called Innovative Solutions, created to address high impact internal challenges that the company had failed to solve. In 2013 they launched the Out of the Box venture capital fund, with an initial investment of USD 8.5 million to fund radically innovative projects that could boost the competitiveness of the company.</td>
</tr>
<tr>
<td>Corona (Sumicol)</td>
<td>Construction, tile coatings, chemicals for construction, new materials.</td>
<td>The company collaborated with EAFIT University to create research groups. They worked specifically on the systematic development of four core technologies in partnership with EAFIT research groups. The firm's Sumicol business unit was recognised by Ruta N as the most innovative in a call where other 60 companies took part. Ruta N underscored the maturity of Sumicol's innovation management system and commended them for their strategic partnership with the University of Antioquia to support and promote the regional innovation ecosystem by developing, producing and applying a portfolio of non-metallic mineral-based micro-encapsulation and nanosystem technologies for use in the food, agricultural, pharmaceutical, medical, cosmetic and chemical industries.</td>
</tr>
<tr>
<td>Concreto – EIA</td>
<td></td>
<td>Concreto partnered with the University of Antioquia for the construction of an innovation centre aimed at providing academic and experimental training to young entrepreneurs. The centre will give trainees the opportunity to work with new materials, equipment and tools. The new facility, designed by CMD Ingenieros of Spain, features cutting-edge technology such as bioclimatic solutions for ventilation and natural lighting, as well as efficient water use. It also includes technological immersion spaces, an ecological structural system, a modular climatic patio, flexible furniture and areas for coffee and snacks.</td>
</tr>
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</table>

37 In interviews held in preparation for this Review, Argos’ managers indicated the company had already assigned a 33-strong core R&D team to this project. Additionally, a first agreement has been reached between the University of Antioquia and Argos to create apprenticeships for more than 30 students for the initial period.

38 Source: Corona Sumicol’s website. http://www.corona.com.co/web/Corporativo/Pages/Comunicado-Sumicol-reconocida-como-la-mas-innovadora-por-Ruta-N
It also must be added the growing presence of new smaller foreign firms with R&D infrastructure and laboratories, recently arrived in Medellin under Ruta N’s Landing programme, and with the support of the Cooperation and Investment Agency of Medellin, which is presented in detail in Chapter 6.

In addition to the above, several initiatives have been deployed in recent years to promote the emergence of new technology-intensive companies. Medellin has developed pioneering initiatives in this area. Among these are the Aceleración programmes and CREAME’s Inn CeleR programme (formerly IEBTA), started in the 1990s as a traditional business incubator but now turned into an organisation dedicated to creating knowledge-and technology-based companies, among them Capitalia Colombia, a provider of financial solutions and services. Other recent initiatives include Cultura E, launched in 2004 by Medellin City Council as a broad platform of promoting entrepreneurship through the creation and development of strategic partnerships between different institutions in the city; the Bank of Opportunities, and the Zonal Development Centres (Cedezos), intended to cater for early-stage companies.

In 2006, Medellin City Council partnered with the University of Antioquia to create the Entrepreneurship Park with the goal of promoting entrepreneurship among college students and support the development of high value-added enterprises. The university provides in-kind resources which are topped up by funds provided by the City Council, which between 2006 and 2012 exceeded USD 6 million, with a trend to increase over time. Parque E has about 23 full-time professionals from all areas of activity, including back office. The target audiences for Parque E activities are students and tertiary or university graduates, professional organisations with extensive experience and knowledge, researchers, technology development centres and higher education institutions. Parque E’s activities are organised around three specific lines of action, depending on the profile of the beneficiaries and the stage of development of their entrepreneurial process. These lines of action are: (a) promotion of entrepreneurial culture, (b) support for business creation and (c) consolidation of companies.

There are now a growing number of providers of smart capital (seed and venture capital) and non-financial services that have turned Medellin into probably the most important urban ecosystem in Colombia and one of the most important ones in Latin America for dynamic entrepreneurship. The facilitator role of Ruta N, through initiatives such as Inngenio and Startup weekend, has been instrumental in this process. Identification and support of new dynamic enterprises has also been possible as a result of the work of private entities such as the Founder Institute. The development of spin-offs of R&D projects developed locally by universities or research and technological development institutions is also high on the agenda.

As regards funding, Ruta N has launched a series of attractive initiatives including the creation in 2012 of an investment fund aimed at providing venture capital funding to young companies with high potential for dynamic growth. This has been possible thanks to an anchor contribution of USD 4 million complemented by funds raised from a call to private investors. The initiative led to the newly created Velum fund, with a USD 10 million base, of which USD 5 million were contributions from the Multilateral Investment Fund of the IDB (MIF); and the rest came from local investors. The offer of smart capital for entrepreneurial projects has been strengthened with the recent establishment of three private venture capital funds.


40 The Cultura E programme encompasses more than a dozen sub-programmes aimed at different segments of the entrepreneurial population (young people, subsistence microentrepreneurs, technology-savvy entrepreneurs, etc.). These sub-programmes focus on diverse components of the entrepreneurial process, such as entrepreneurial culture, project development, capacity-building, and funding, among others (Kantis et al., 2012).
funds for companies in the early stages of development, and has been complemented by already mentioned entities such as Capitalia Colombia.\footnote{Two out of the three funds were setup by EPM and Grupo Nutresa. The third was set up jointly by Socialatom and Ruta N. Further information at: http://www.socialatomventures.com/}

Furthermore, the platform created to support business development includes a variety of institutions ranging from banks and venture capital funds (Interactuar, Banco de las Oportunidades, Coomeva Foundation Antioquia Guarantee Fund, Medellin Capital Fund) to promotion, information and communication agencies, intellectual property management organisations and technical and healthcare standards regulators (Invima), each seeking to make their own contribution to the maintenance and development of the system. Among the employers’ organisations in Medellin that support and promote entrepreneurship are ANDI, ProAntioquia, ACOPi, FENALCO, both COMFAMA and COMFENALCO benefit funds, as well as the Chamber of Commerce of Medellin and entities that support the dissemination of the culture of innovation such as libraries, museums and parks. Additional funding is obtained from programmes, competitions and contributions from national government agencies such as Innpulsa and SENA’s Emprender fund and entrepreneurship units.

In the field of promotion of innovation and competitiveness of local businesses, the work of ProAntioquia Foundation deserves special recognition. The Foundation was formed as a result of an initiative of local and regional companies and the National Association of Industry (ANDI) aiming to promote regional development. ProAntioquia is a major contributor to virtually all initiatives related to the region’s innovation, science, entrepreneurship, education and social development.

Another important initiative to boost business-driven demand for innovation is the aforementioned Medellin Ciudad Cluster strategy, led by the Chamber of Commerce of Medellin, Medellin City Council and different entrepreneurs who have participated in the development and articulation of each cluster and still play a role in their operation today. As recognised by Medellín’s STI Plan, the underlying idea behind the cluster concept is to create partnerships between companies, contractors, customers and suppliers of raw materials, machinery, equipment and services aiming at improving cooperation and specialisation in the business sector, leading to collective efficacy, and enhancing the firms’ capacity for innovation in processes and products.

The local cluster strategy is currently being reinterpreted into a territorial smart specialisation strategy. The STI Plan identifies global market opportunities with high innovative potential for the energy, ICT and health clusters (referred to in Table 9 above). A recommendation is made to abandon the sectoral dimension and target clusters dealing with more cross-cutting concepts such as welfare or smart cities, recognising the nature of their competitive maturity. In this way, areas of potential collaboration in STI would become cross-cutting platforms rather than water-tight sectoral compartments.

The emphasis given by the STI Plan to these market opportunities, seeks to widen the scope of the specific competitive advantages that can be constructed on the basis of certain assets, vocations and territorial possibilities, inspired by what is recognised today as a smart specialisation approach (Navarro, Aranguren and Magro, 2012). Although this new emphasis can be considered a natural evolution of the Medellín Ciudad Cluster programme, some critical differences exist in its perspectives and assumptions. The idea is not just to prioritise certain industries for which to establish competitive sectoral plans or agendas, but to complement the prioritisation of sectors, subsectors and enabling technologies with the identification of global market opportunities based on manifest or latent competitive advantages. On the one hand, it is essential to adopt a broad functional perspective, considering the increasing fragmentation of global production chains in all industries and especially in those with highest added value. On the other hand, promoting the development of related variety as an agglomeration model for the activities of various
value chains that share STI capabilities is equally important (Henning et al., 2010). For example, it is not enough to select the ICT sector as a priority cluster; it is also required to develop opportunities based on technology and market foresight; define what activities or functions may emerge within the sector; and, further to the development of related variety industries, choose the productive activities or services that may benefit by the competitive advantages arising from the developed ICT-driven activities and functions.

The review of the Medellín Ciudad Cluster initiative also raises the convenience to develop different cluster- and segment-specific strategies. The idea is to better align the specific challenges faced by each business segment within a cluster. In retrospect, the original selection of the six clusters of the programme was justified, given their relatively better performance in terms of income, employment and exports, though not all six had the same dynamism (Chamber of Commerce of Medellín, 2009 and 2011). For the future, however, the Chamber of Commerce and Ruta N have agreed on the need to identify specific agendas with different emphases depending on whether the competitive environment of each industry is undergoing transformation or conversion, sophistication, or experimentation.

Coordination between the local supply of knowledge and investment opportunities in STI

The main universities in Medellín, the National University, the University of Antioquia, the University of Medellín, the Antioquia Engineering of School, EAFIT University, CES University, Lasallista University Corporation and Universidad Pontificia Bolivariana, have shaped the G8 group as a "task force" and the dean of each university plays an active role in the functioning of the group. The G8 agenda includes several common themes, beyond innovation, thereby providing a rather exceptional instance of consensus and coordination between the heads of the participating entities. Recently, Medellín City Council established a higher education agency called Sapiencia Alliance as a new platform to integrate the efforts of local technological universities (the Metropolitan Technological Institute (ITM), the Colegio Mayor de Antioquia and the Pascual Bravo University Institute) with the goal of creating synergies around building training infrastructures, disseminating information, promoting university-industry collaboration, and working on management and technology transfer processes.42

A number of different facilitators, enablers and catalysts play a vital role as knowledge brokers within Medellin's innovation system. One of them is the Centre for Science and Technology of Antioquia (CTA), with a regional orientation and various applied and prospective R&D research projects, which is spearheading the Enplanta project, aimed at bolstering the productivity of SMEs.43 Another one is Tecnova, a specialised entity created by the University-Government-Industry Committee (CUEE), which has become a model of collaborative STI activity, intersectoral innovation and technology transfer, and is playing an outstanding role both in Colombia and internationally.

In more focalised areas there are multiple targeted Technological Development Centres (CDT), all of them actively working on R&D and technology extension projects in different sectors related to STI.

Some of these centres and corporations are:

- ARTICA, Regional Alliance for Applied ICT (linked to EPM)
- CIIEN, Centre for Energy Research and Innovation (linked to EPM)
- CORPOICA Colombian Agricultural Research Corporation (linked to the Ministry of Agriculture)

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43 EnPlanta programme’s website: http://www.cta.org.co/component/k2/item/6-enplanta
There are also several local entities located around technology parks that also play a promoting and coordinating role. Their main task is precisely to connect supply and demand with physical structures aimed at encouraging investment in technology. Finally, there are the so-called productivity centres such as Socya (formerly Codesarrollo) and the aforementioned CTA, whose functions include providing research and development services, particularly applied research, to SMEs.

**SWOT Analysis**

As noted in this chapter, Medellin has developed a growing critical mass of institutional actors, which positions the city favourably in terms of density of its local STI system as compared to other metropolises in Colombia and Latin America. This local institutional fabric plays different roles, such as promotion, networking, knowledge generation, support of innovative entrepreneurship and packaging and transfer of technology, and also promotes partnerships and exchanges with recognised peer institutions both in Colombia and abroad. The relative strength of the system is no coincidence but the result of a permanent effort by the City Council in collaboration with the departmental governorate. As noted in previous chapters, a huge milestone along the way has been the creation and operation of Ruta N under a financial sustainability model that enables it to act as a facilitator and enabler of the local STI system. Ruta N’s work is guided by a roadmap based on the STI Plan 2011-2021 and by multiple complementary studies commissioned to internationally recognised entities.

However, as at the national level, the business sector in Medellin is not located at the heart of the local innovation system. STI investment by business actors is mostly limited to a dozen large companies, which together add up to a high market capitalization, whose capabilities and requirements are located in the city, and are likely to exhibit a sophisticated potential demand for STI. Apart from these, mention must be made of the global companies that have installed R&D capabilities in the city, and the emergence of new local and foreign knowledge and technology-based enterprises.

The advances in innovation management by some Medellin-based business groups (multilatinas) open the opportunity to disseminate to other smaller firms their own experience of the benefits and results of introducing an innovation culture in their companies. This can exert a highly positive multiplier effect.
SWOT Analysis

<table>
<thead>
<tr>
<th>Strengths</th>
<th>Opportunities</th>
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<tbody>
<tr>
<td>• Commitment of local leaders with STI and the knowledge economy.</td>
<td>• Smart specialisation strategy aimed at capturing global market opportunities (based on the Medellin Ciudad Cluster programme) to effectively address market coordination and intelligence issues, promoting economic concentration based on related variety.</td>
</tr>
<tr>
<td>• High Density and wide variety of actors in the local STI system.</td>
<td>• Recent creation of a significant number of private and mixed investment funds designed to capitalise innovative and/or recently created technology-intensive ventures. Wide base of SMEs (equivalent to 97% of all enterprises in the city) towards which capabilities, enabling behaviours and innovative practices should be directed.</td>
</tr>
<tr>
<td>• Existence of a segment of larger and more global companies that generate a significant demand for innovation.</td>
<td></td>
</tr>
<tr>
<td>• Ruta N’s role as the main player in the STI Plan, a governance paragon, a facilitator and strategic enabler of the local STI system.</td>
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</table>

<table>
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<tr>
<th>Weaknesses</th>
<th>Threats</th>
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</thead>
<tbody>
<tr>
<td>• Inconsistency and limited reach of public instruments offered by national authorities for business investment in STI.</td>
<td>• Low deal flow of new dynamic high potential entrepreneurial initiatives considering the current availability of venture capital.</td>
</tr>
<tr>
<td>• Limited scope of the current areas of collaboration between research groups and the business sector.</td>
<td>• Risk that the expansion of the universe of local companies with systematic innovation capacity may be too modest or too slow to narrow current productivity gaps between different sectors.</td>
</tr>
<tr>
<td>• Legal restrictions on spin-offs of public research.</td>
<td></td>
</tr>
<tr>
<td>• Significant number of micro and small businesses that operate informally, with low productivity and high job insecurity.</td>
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Recommendations

The recent OECD Review of Colombia's National Innovation Policy (OECD, 2014) clearly underscores the importance of taking advantage of Colombia's economic performance and the level of development reached by the country during the last decade to place the business sector at the heart of the innovation system, which is common practice in advanced economies and also in the more dynamic emerging economies. Companies are the main source of dynamism in all high performing innovation systems and help stimulate the activities of universities and research institutes. Medellin’s local STI system is denser and more highly developed than that of other medium-sized and even larger cities in Colombia and Latin America. Nonetheless, emphasis should be placed on overcoming the current weaknesses preventing companies from making greater investments in STI.

Traditional paradigms that consider business innovation as the last stage of a linear process that goes from basic research to applied research, then to technological development and finally to production have fallen out of favour since they do not explain how the vast majority of innovation processes take place in practice. A more realistic view considers that basic research contributes to a body of knowledge that only indirectly influences the innovation process. Responding to the challenges and opportunities associated to the launch of new or improved products and services to the market is the main driving force behind every innovation process. And then, of course, the encounter between the supply of knowledge and business-driven (or entrepreneurial) demand for innovation is a crucial element to achieve high rates of private investment in STI.

44 For further details, see Table 12 below.
The recommendations below therefore take into account the systemic nature of the innovation process in the business sector. Six concrete proposals are formulated with a view, first of all, to strengthening capabilities and the environmental conditions for private investment in STI; secondly, to stimulating business-driven demand for innovation; and thirdly, to promoting coordination between supply and demand for STI. These recommendations should be considered consistent with and complementary to the strategic guidelines presented in the first chapter.

In order to enhance the skills and environmental conditions required to promote business investment in STI, the following recommendations are proposed:

1. Promoting a **smart specialisation strategy** for business areas and industries that may help position local companies in global markets. Because of its scope and cross-cutting nature, this proposal is meant to provide strategic guidance for Medellin's regional innovation system.45

2. Creating an environment that is conducive to highly innovative technology-based start-ups.

In order to directly stimulate demand for business innovation the following recommendations are proposed:

1. Implementing a regular co-funding programme for innovative projects submitted by SMEs and local social organisations.

Promoting and supporting programmes aimed at developing highly innovative local suppliers and, at the same time, identifying and executing technological dissemination initiatives targeted at SMEs, in order to meet the standards and requirements of Medellin-based multilatinas and global companies. Finally, in order to balance supply and demand for STI within Medellin's regional innovation system, three recommendations are proposed:

1. Promoting the establishment and operation of triple helix programmes that co-finance the development of technological roadmaps encouraging the collaborative participation of universities, R&D centres and businesses, building on the Competence Centres promoted in European countries since the 1990's.

2. Establishing multilevel trust funds ("mixed funds") to finance enabling investments and joint R&D&I initiatives between universities and research centres, and to promote corporate technological development.

3. Creating and making available platforms and channels that may bring the supply of Medellin-based smart capital and local initiatives together with the demand of companies of high growth potential.

*The Medellin Ciudad Cluster programme should implement a smart specialisation strategy around global market opportunities aimed at existing and emerging enterprises in the energy, ICT and health clusters.*

Drawing on the recommendation in the STI Plan that greater attention should be paid to segments with high potential for internationalisation, on the basis of differentiating their competitive advantages with respect to knowledge and innovation, a territorial smart specialisation strategy is proposed as a new phase of the *Medellin Ciudad Cluster* programme.

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45 See Table 12 below.
The priority business areas outlined in the STI Plan include engineering services, smart transmission and distribution networks and energy eco-efficiency for the energy cluster; technology platforms, network architecture, animation and digital content for the ICT cluster; and technology platforms for e-health and supply chain services internationalisation for the health cluster.

The change from a cluster prioritisation approach towards a smart specialisation perspective makes it possible to focus - rather than on specific sectors - on global market opportunities that make it possible to develop knowledge and technology-intensive goods and services that provide the city with a competitive edge. This approach provides broader and systemic tools than traditional programmes aimed at identifying and constructing agendas around clusters with competitive potential. Indeed, the new approach incorporates the concept of roadmaps to address gaps related to key competitive factors such as technology, design, human resources, quality, and market access (OECD, 2013).

The development of roadmaps derived from global market opportunities addressed to clusters, enabling technology platforms and emerging sectors makes it possible to develop multiple dynamic value chains simultaneously, while stimulating an offer of smarter business services based on the market gaps identified in areas such as research and development, human talent management and retention, technological capacity-building, or market intelligence.

Table 12 schematically shows the main elements that distinguish the smart specialisation approach from the more conventional cluster prioritisation approach. Although both approaches are not mutually exclusive (territory clustering is an important process also for smart specialisation) the assumptions and implications of both approaches for STI strategies and for the promotion of regional innovation systems differ substantially in terms of the type and scope of the prioritisation proposed.
Table 9. Comparison between cluster prioritisation and the smart specialisation strategy

<table>
<thead>
<tr>
<th>Key assumptions and implications</th>
<th>Cluster prioritisation strategies</th>
<th>Smart specialisation strategy</th>
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<tbody>
<tr>
<td>Potential competitive energisers (depending on level of development)</td>
<td>Competitiveness based on production factors; Competitiveness based on efficiency and investments Innovation-based competitiveness</td>
<td>Closing gaps (catching up); Socio-economic transformation; Innovation and dynamisation of scientific and technological advantages</td>
</tr>
<tr>
<td>Aggregation-based underlying model</td>
<td>Based on sectoral specialisation</td>
<td>Based on functional specialisation and related variety</td>
</tr>
<tr>
<td>Main interrelations</td>
<td>Intra-cluster: horizontal networks and vertical articulations along the value chain</td>
<td>Activities or specialised functions in broken chains; advantageous insertion into production networks and global value chains</td>
</tr>
<tr>
<td>Nature of the main competitive advantages</td>
<td>Collective efficiency and endogenous innovation dynamics</td>
<td>Overcoming coordination failures and generating superior balances in investment and innovation to capture global market opportunities</td>
</tr>
<tr>
<td>Strategic directions to sustain and improve the competitive advantages achieved</td>
<td>In-depth analysis and specialisation in priority clusters; concept of learning regions based on benefits already achieved.</td>
<td>Adapting to change and reinvention; concept of innovating regions based on STI assets.</td>
</tr>
<tr>
<td>Nature of strategic STI challenges</td>
<td>Focused on key core competencies for prioritised clusters</td>
<td>Balance between different territorial STI asset types. Combination of different learning styles and trend toward open innovation processes.</td>
</tr>
</tbody>
</table>

Source: Prepared by the authors on the basis of on Foray, David and Hall (2009); Navarro, Aranguren and Magro (2012); and OECD (2011 and 2013).

In essence, smart specialisation emphasises on innovation and concentrating scarce human and financial R&D&I resources in a few globally competitive areas (Navarro, Aranguren and Magro, 2012). A smart specialisation strategy typically draws on the following strategic objectives:

- Retooling, aimed primarily at improving the human and technological resources of an existing industry;
- Self-discovery, further to the appearance of an attractive new business activity resulting from the convergence between an existing R&D&I activity and a related business activity;
- Extension into a newly discovered niche by applying cross-cutting technologies in emerging businesses areas; and
- Cross-sectoral scope, which refers to a novel combination of sectors that can generate innovative ideas for new products and services.

An example of integration of this perspective into the generation of new policies is the Dutch "Innovation Programmes in Key Areas" initiative, whose goals are defined in terms of specific topics, e.g. generation and animation of digital content; technological domains, e.g. nanotechnology; or major challenges to society, such as the development of ICT-based solutions for smart cities (OECD, 2011).
The Regional Innovation Initiatives (RII) sponsored by Ruta N under the STI Plan, as long as they are projected for at least five years and its members can access different local, department and national funding streams, could become key projects within Medellin’s smart specialisation strategy. A very relevant example of the smart specialisation approach applied to technology domains is the European Commission’s initiative on key enabling technologies (KETs).

Box 16. European Commission’s initiative on key enabling technologies (KETs)

The European Commission’s Report on KETs establishes the obligation to strengthen and sustain capabilities throughout the whole innovation chain: technology research, product development and advanced world-class manufacturing, to boost the competitiveness of European economies. This is only possible to the extent that there is a skills base in the following key technologies:

- Nanotechnology
- Micro and nano-electronics
- Industrial biotechnology
- Photonics
- Advanced materials
- Advanced manufacturing systems

In this context, the design of strategic European networks specialised in each of these technologies is proposed in order to support incremental and disruptive innovations in various application fields such as energy, transport, chemistry, the environment, telecommunications, among others. In terms of the value chain, the overall commercialization potential of these key technologies is expected to reach USD 1.3 trillion by 2015.

**Improve the environment for innovation-intensive technology-based start-ups.**

In the most dynamic economies, one of the most important sources of business investment in STI corresponds to innovation-intensive technology-based start-ups. The pro-entrepreneurship policy implemented in Medellin stands out nationally for its far-sightedness. And recently, the joint effort made by Ruta N, private investors and local economic groups has allowed the consolidation of a smart capital supply of an estimated USD 150 million. The availability of these funds makes it imperative to generate a significant flow of new business projects, encouraging local entrepreneurs and attracting external entrepreneurs. Ruta N has been promoting initiatives in this field with universities and pro-enterprise networks both nationally and internationally, an effort that must be sustained and extended in the near future.

One of the steps that could be taken to help consolidate the framework of favourable conditions to stimulate the entrepreneurship ecosystem at national level would be to adapt the current tax incentive scheme for investments in STI, administered by the CNBT. Specifically, special tax incentives could be introduced for young companies investing in STI, thereby expanding the current scope of the mechanism established by the Law of Fiscal Incentives for R&D in the Business Sector by giving young STI-based

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47 Information provided by Ruta N. The amount includes management capital, i.e. unpaid contribution of managers to start-ups.
48 See table 10 above.
companies preferential treatment in order to facilitate their development and capitalisation in the early stages.

A good example of this type of incentives is provided by the JEI programme implemented a few years ago in France. The programme has established a set of tax incentives to support the creation and development of new R&D-intensive firms during their first seven years of life.

**Box 17. Young Innovative Companies Programme - JEI (France). Tax incentives for business innovation and creation of new businesses**

The French experience of providing tax subsidies to encourage companies to engage in research and development activities began in the eighties, when the Research Tax Credit (CIR) initiative was introduced.

Later, in 2004, France launched the Statute of Young Innovative Companies (JEI), which consists on a set of incentives, compatible with the CIR, aimed at supporting the creation and development of new R&D-intensive companies for the first seven years after their establishment. The JEI Statute was a pioneering initiative for promoting the entrepreneurial ecosystem since it provided additional incentives aimed at creating and supporting new STI-based SMEs. Some of the tax exemptions currently available in Medellin have been influenced by the JEI programme.

In France, the JEI experience was particularly beneficial to regions with already installed R&D&I capabilities. This means that, if a similar programme was introduced in Colombia, one of the regions that would benefit the most would be Antioquia, mainly Medellin given the abundance of start-ups in the area.

For more information see the complete description of this programme included in Annex A.

Another important initiative to enrich the local ecosystem of dynamic enterprises is the publication of international rounds of applications aimed at attracting to Medellin entrepreneurial talent from highly developed ecosystems such as Silicon Valley, Israel, Massachusetts, Asia-Pacific as well as from dynamic European regions, among others, encouraging them to establish all or part of their business base in the city and participate in partnerships with local entrepreneurs, so that local firms have access to the opportunity to expand their business internationally.

A pioneering initiative in this field, implemented in recent years in Latin America, is the *Start-Up Chile* programme. The initiative was designed to attract entrepreneurial talent and connect it with the local ecosystem. Applicants may either be Chilean entrepreneurs (20% of total) or foreign businesses, but partnerships must always incorporate at least one member from abroad and formulate a business plan aimed at international expansion. Since its inception in 2011 the programme has attracted more than 12,000 applicants, of which about 800 have received an incentive that includes an equity contribution of USD 40,000 and a six-month Chilean work visa for the leader or foreign member of each project. *Start-Up Chile* has achieved widespread international recognition as a brand, and has made a durable contribution to the creation of links and networks between local and foreign entrepreneurs.

To date, due to its relatively short life span, no conclusive assessments are available regarding the actual impact of the programme in terms of the economic valuation of the supported projects that have been successful. According to CORFO, about 30% of the projects supported were still up and running in the country after at least two years.

49 For further details on the programme, see CORFO’s Website at: http://www.corfo.cl/programas-y-concursos/programas/concurso-emprendedores-globales-startup-chile
Regular co-funding programme for innovation projects by companies - preferably SMEs- and local social organisations

Innovation is generally promoted by companies, whether existing or new, and what motivates these firms is the desire to be able to respond to market trends and seize market opportunities. The answer to the question "how to develop products and processes that give us a market?" is clearly innovation. The process of designing and redesigning products and processes gives rise to the need for advanced scientific knowledge and human capital and for the ability to interact with designers and technological developers. Similarly, when it comes to generating social impact at community level, it is social organisations with a local presence that are in a position to develop innovative processes, incorporating and integrating the knowledge required to meet the needs of society.

Since the entry into force of the royalty fund, the unprecedented availability of abundant funds to invest in science, technology and innovation, in the region of Antioquia, has given Medellin a unique opportunity to clearly define its vision on the challenges faced by the local STI system, its strategic objectives, policy priorities, and the institutional basis needed to ensure the sustainability of the Fund as well as its effective and efficient implementation.

In that context, the role played by the demand of the business and social sectors could be crucial. In fact, it could be necessary to generate demand-pull mechanisms for identifying and selecting projects for the STI fund. The idea would be to establish a percentage of the royalty funds to be allocated directly to projects proposed and led by local entities, preferably MSMEs and social organisations. This regional allocation could be topped up by funds from the Innpulsa programme, already implemented at national level; and accompanied by coordination -and where possible, consolidation of calls; and a standardisation of the criteria to be met by beneficiaries and by co-funding entities. Funding agreements could establish that Innpulsa would provide funds for the execution of calls and that the selection and monitoring criteria would be decided at regional level (in a decentralized way). These changes would require greater coherence and coordination between national, regional and local instruments.

It would be desirable to establish, with the support of the already mentioned funding streams, a Ruta N-operated one stop shop system where applicants could submit their innovation projects (in the proof of concept, prototyping and pilot phases) so as to avoid dispersion of efforts and reduce transactional costs for businesses interested in accessing these mechanisms. The funding for a project could be higher when the applicant is an SME or a local social organisation.

Note that public non-refundable schemes, or those subject to contingent repayment, aimed at funding business innovation projects at pre-commercial stages are widespread in OECD countries, with 50% of innovative manufacturing firms in countries like Canada, South Korea or the Netherlands, regardless of their size, benefiting from them. In Chile and Australia, between 15 and 20% of the innovative companies benefit from these public co-financing schemes (OECD, 2010b). Their application in Colombia should take into account the models and best practices of other countries. In any event, promoting the legal and regulatory reforms needed to implement these schemes in Colombia would greatly benefit entrepreneurial innovation projects.

Develop highly innovative local suppliers and disseminate enabling technologies across local SMEs, based on the standards and requirements of Medellin-based multilatinas and global companies

The presence of a group of multilatinas with corporate headquarters in Medellin, alongside a local base of new technology-intensive start-ups, and a series of international companies that have moved STI infrastructure and capabilities to the city constitute a basis for potential demand of specialised knowledge and innovation that is quite exceptional in the Latin American context. Knowledge brokerage agencies
such as Tecnova, the university-government-industry committee and CTA, among others, are tasked with linking this demand with an offer of R&D services that is attentive to the requirements of the business sector. Moreover, multinational companies can act as an incentive for the development of highly innovative local companies, which could become part of their supply chain and address their productive and technological needs. Also, larger companies could sponsor STI projects and encourage keen suppliers to help them solve any challenge they may be facing. However, guaranteeing the fairness of contractual conditions, especially with regard to suppliers’ intellectual property, is of paramount importance.50

In this connection, programmes aimed at developing suppliers so that they are able to address the technological challenges of their large corporate customers can be effective mechanisms to stimulate the generation of innovative capabilities and behaviours in local SMEs. Another formula for large companies to promote innovative behaviours and practices is to define standards to be met by their SME suppliers, where intermediary institutions, such as productivity centres, can collaborate in facilitating the adoption of such standards. Companies like Petrobras in Brazil and BHP Billiton in Chile provide good examples in this respect, but the programme with the longest experience and most significant results in supplier development is the Australian Austmine programme, which in its 10 years of existence has been a success in terms of increasing suppliers’ export capacity of goods and services with high added value.

Box 18. Austmine Programme for the development of highly innovative suppliers for the mining industry (Australia)

The Austmine Programme is an initiative driven by tractor companies in the mining sector aimed at identifying opportunities for innovation that could impact their suppliers’ competitive performance.

They operate following a selective and gradual itinerary along their path toward innovation. Suppliers (and the challenges that warrant their inclusion in the programme) can be classified on the basis of their relative technological sophistication level.

Contracts with participating vendors are contingent on the results achieved through the project. At the same time, suppliers are given advice on the competitive capabilities they need to incorporate with a view to their future internationalisation. A crucial aspect of the programme has been the condition that suppliers must preserve intellectual ownership over any solutions found. Tractor companies benefit by a right of preferential use of the relevant licenses either at no cost or enjoying temporary exclusivity, as agreed in each case.

This initiative has inspired the design and implementation from 2009 to date of the “World-class supplier” programme for the mining industry in Chile, promoted by leading mining companies in the country, with support from CORFO and Fundación Chile.

Source: www.austmine.com.au

It is known that the size of a company directly affects its capacity to innovate. SMEs worldwide, particularly in developing economies, face serious constraints due to their size. Small size results in weaker innovative performances and fewer possibilities of using technologies in a productive way. Notwithstanding their heterogeneity, SMEs often face common obstacles that hamper their ability to innovate. The main ones are the difficulty to access credit and qualified human resources, lower export propensity, their limited ability to interact with other companies and training and research institutions, and negligible participation in networks. Additionally, in Medellin, as in most Latin American metropolises,

50 Supplier development programmes established by large companies such as ISAGEN, EPM and Argos, among others, should be subject to a detailed comparative analysis so as to identify best practices and promote such programmes in other business sectors to foster high-growth potential innovative start-ups.
the relatively smaller companies tend to focus on areas such as trade, informal services and basic manufactures, which, by virtue of their nature face unsophisticated demands, which do not provide any stimuli to develop innovative behaviours.

As a result, incorporating innovative capabilities and behaviours in SMEs must necessarily be a gradual learning and assimilation process, focusing initially on technology transfer and imitation. This process must be accompanied by implementation of new techniques and acquisition of machinery and equipment (OECD/ECLAC, 2012).

In particular, incorporation of ICTs by SMEs, including progression from simple to more specialised applications, is one of the most productive areas of technological knowledge acquisition. For SMEs, incorporation and use of ICT tools requires a major training effort as well as the possession of certain previous skills.

Consequently, supplier development programmes by leading Medellin-based companies should include technology-dissemination programmes addressed to local SMEs interested in joining different supply chains. Such programmes should include modules on enabling processes such as electronic invoicing and support tools such as Enterprise Resource Planning (ERP) and Customer Relationship Management (CRM). Other modules could comprise technology assimilation visits to leading R&D centres and participation in sectoral technology transfer activities and learning and collaboration networks. One-third of the funding for these programmes would come from the contributions of leading companies, another third could be contributed by participating SMEs and the remaining third would (one third) be a non-refundable contribution of public funds. The initial design stage would require multilateral support for identifying best international practices in this type of programmes, already implemented in Asia Pacific, Eastern Europe, and in Latin America, in Chile and some states of Mexico.

**Promote the establishment and operation of triple helix programmes**

A key attribute of every vigorous STI system, which applies to the case of Medellin, is the necessary participation of players of the local innovation system in national and international open knowledge and innovation networks, either through the establishment of external capacity in Medellin, as will be discussed in Chapter 6, or by a close articulation between the actors in the local system. Both approaches contribute significantly to stepping up business involvement in STI-intensive projects. In the case of Medellin, the fact that numerous multilatinas and global companies have established their corporate headquarters or specialised divisions in the city accentuates this need. Against this background, local universities and R&D centres can play a valuable role as a smart link between companies and international research centres that lead the way in specialised areas. The experience of the Technology-Business Consortia in Chile, which dates back to 2004, illustrates this type of connection and its potential impact. The Chilean initiative was inspired by the success of the Collaborative Research Consortiums (CRC) of Australia. In turn, these programmes were inspired by the Competence Centres promoted in European countries during the nineties (OECD, 2014).
Box 19. Technology-Business Consortia (Chile)

Since their inception in 2004, the Technology-Business Consortia have been promoted and co-funded by the InnovaChile Committee, under CORFO (the Chilean Economic Development Agency) in coordination with CORFO's regional offices. The latter liaise with the planning departments of the relevant regional governments to identify the STI-related requirements of the business sector to find out whether they fit in with regional strategic priorities (regional development strategies, regional innovation strategies or agendas). The term consortium emphasises the collaborative commitment assumed by the actors involved, which may or may not lead to the creation of a legal entity for a specific project.

The model offers funding for both the creation and the development of a consortium geared to the formulation of R&D projects that can lead to the formation of business partnerships. Projects must be aimed at production and may be located in a specific territory. The commercial feasibility of the outcomes pursued is one of the criteria for selection. Companies can participate as partners and enter into a joint execution contract or subcontract with the following goals:

- developing market-oriented innovation projects
- incorporating technology partners and business facilitators at an early stage
- establishing partnerships between domestic or foreign technology-oriented businesses and entities
- formulating business strategies on the basis of the innovative products and results obtained from the implementation of development projects and technological innovation

During the period 2004-2009 a total of 118 research projects were formulated by 16 consortia. The total investment was about USD 7 million. The projects were related to the following sectors: agriculture, ICT, renewable energies and pharmaceuticals.

Under the last call, published in the second half of 2013, eight new consortia were formed, each of which is expected to invest about USD 120 million in various research and development projects within the next ten years. If this total investment finally materialises, CORFO will have contributed 43% of the resources mobilised by the programme.

The Chilean science-technology-industry model has shown itself to be effective at matching the supply of knowledge with the corporate demand for R&D&I, and has also promoted the technological development of specific business sectors providing both collective and regional benefits. Colombia's institutional organisation and the existing channels to promote regional innovation (departments) are well suited to adapt the Chilean consortium model to the Colombian context through the mechanisms available to Colciencias or Innpulsa. The participation of the Antioquia Governorate could also be considered through funding from the STI fund.

For further information see the complete description of this programme in Annex A.

Implementing multilevel trust funds ("mixed funds") to finance enabling investments and joint R&D&I efforts between universities and research and technology centres and companies

Medellin's local innovation system, like many others, faces coordination problems that hinder, on the one hand, a satisfactory match between the supply of capabilities and demand of STI services and, on the other, the generation and availability of publicly-owned innovation-enabling assets such as shared technological equipment, rules and standards, or an acquis of highly specialised information. Both problems have resulted in the development of gaps that tend to inhibit investment and innovation in specific industries or production processes. To narrow such gaps a trust fund-based mechanism could be activated that encouraged the formulation and implementation of collaborative projects between
universities, R&D centres and industry, or the generation of enabling public assets for the development of innovations and collective, or “club”-type investments, by local companies. Such a trust fund would benefit from multilevel (national, state and local) contributions from both public and private sources. It goes without saying that the establishment and activation of a trust fund is not necessarily a cure for the gaps mentioned, but it does provide a funding stream that is not crippled by the budget constraints characteristic of conventional public mechanisms, while allowing contributions from public, private and multilateral sources. Appropriate regulations and the orientation of the Fund toward bridging the referred gaps are key elements in this strategy.

An example of the potential role of public mechanisms in facilitating an appropriate match between supply and demand for STI is the case of the mixed funds implemented by CONACYT in Mexico. A similar case in Colombia is the FJ Caldas fund, created under Act 1286 and under the administration of Colciencias (Doc CONPES No. 3582, 2009).

Box 20. Multilevel Mixed Funds (Mexico)

The Mixed Funds programme is a decentralisation policy aimed at the development of regional STI systems. It originated in the need to bring together public and private efforts under the leadership of the state and municipal governments in partnership with CONACYT. For this purpose, the federal government and the states joined forces to create a trust fund, which caters for specific local demands, identified at regional level. At twelve years from its establishment, the fund has emerged as an effective mechanism for investment in STI. Thirty-five mixed funds have been created across the country, with an approximate contribution of USD 530 million. 51

Mixed Funds have allowed not only the transfer of resources to the regions, but have introduced significant changes in infrastructure and production of local knowledge. These enhanced capacities have strengthened the bond between science and industry thanks to the development of sectoral and intersectoral applications that directly impact regional competitiveness.

Finally, this experience has led to a renewed local governance based on an improvement of the institutional system, which has radically changed the role of municipal governments which are now more keen to participate in the formulation of policies of regional interest further to the realisation that science, technology and innovation, unquestionably affect the economic, social and environmental development of their territories.

For further information see the complete description of this programme included in Annex A.

Establish and disseminate platforms and channels that facilitate the meeting between the supply of smart capital established in Medellin and the demand of local enterprises or companies with high growth potential

The recent establishment of private investment funds in Medellin has resulted in the availability of a significant supply of venture capital for companies with high growth potential at their initial or subsequent stages of development. The experience of these funds in countries in the region such as Mexico, Chile and even Colombia, has been that the investment portfolios of these funds are usually quite limited because of the limited amount of eligible business projects. This poor performance is often due to the existence of significant information asymmetries that impede a smooth and timely meeting between funds and candidate projects.

The availability of smart capital is a necessary but not sufficient condition to ensure the emergence of a dynamic entrepreneurial ecosystem. International experiences indicate that it is also necessary to

51 Of which 32 regional and 3 municipal in 2012.
establish policies and incentives that spur demand as well as an environment conducive to dynamic entrepreneurship development (LIFT Growth & Innovation, 2013). 52

On some occasions, a project may be given the green light by the fund but the transaction may however not go through because the equity made available is not enough to meet the needs of the relevant enterprise. A proposal has been made to address these equity gap problems, often resulting from information asymmetries, by introducing the figure of an honest broker in the negotiation process. Tecnova or Ruta N itself could easily play the part of a recognised and neutral mediator between the two parties.

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52 The entrepreneurial environment takes into account the supply of non-financial services to start-ups, the legal-regulatory entrepreneurial framework as well as tax-related and even cultural issues.


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CHAPTER 5
PUBLIC POLICIES TO PROMOTE DEMAND FOR INNOVATIVE PRODUCTS AND SERVICES

In studies of science, technology and innovation, there has always been a tension between models that assume that the fundamental source of innovation lies in the results from R&D activities, which are subsequently channelled to the market (supply-push), and those postulating that the most important force behind innovation lies in unmet user demands, which indicate the routes to be followed by firms when developing new products and services (demand-pull). Today there is a strong consensus in recognising that the two routes are equally important and must be taken into account simultaneously in the design of innovation policies, seeking ways to better articulate policies aimed at strengthening the supply of STI with measures to promote demand for innovative products and services. This necessary coordination between supply and demand requires a change of mindset, from the so-called linear model of innovation prevalent in the past - based on the commercialisation and transfer of public research results to the industry and the market - towards a more interactive model based on collaboration and co-production of knowledge, where the emphasis moves towards the formation of networks and partnerships between actors (Edquist and Hommen, 1999).

Against this theoretical debate, in most countries a strong influence of the linear model of innovation persists in public policy, which often focuses almost exclusively on stimulating supply through public investment in R&D or the provision of incentives for innovative companies, without devoting sufficient attention to the articulation of demand. As evidenced by Arocena and Sutz (2010), this bias in policy is particularly severe in developing countries, and Latin America in particular, as weak demand for innovative products and services by businesses and consumers can be regarded as the main barrier to technological progress. Likewise, the interviews conducted for this Review, and the analysis of the main documents published by the national and local governments, support the view that demand-side innovation policies are not sufficiently integrated into the current political discourse or innovation plans in Colombia in general and in Medellin in particular. However, although they have not been explicitly classified as demand-side innovation policies, some relevant initiatives have been launched in recent years in this area at both national and regional level, which will be summarised in this chapter.

In recent years an increasing interest is observed in almost all OECD countries for demand-side innovation policies (Georghiou et al, 2013. OECD, 2011). The underlying aim is to stimulate demand for innovative products and services, to create incentives for business innovation and accelerate the diffusion of new technologies. Another key objective of these policies is to channel innovation into priority areas of society such as health, transport infrastructures or environmental protection, among others. Thus, demand-side policies allow combining innovation policy with other policy areas to stimulate innovation and direct it towards societal needs.

There are various policy instruments that can be used to stimulate demand for innovation:

- **Innovative public procurement:** public procurement can increase demand for innovative products and services by public authorities, acting as an engine for the innovative efforts of companies and research groups.
• **Incentives for innovative products and services:** the government can try to stimulate private demand by offering incentives to consumers who buy innovative products and services through tax deductions or subsidies.

• **Regulations and standards:** governments can modify the regulations and standards of products and industries with the aim of inducing innovation, forcing companies to innovate to meet new regulations. Regulations and standards can impose conditions on product characteristics (quality, compatibility) or the consequences of product use (health, safety, and environment).

• **Promoting an innovation culture:** domestic demand for STI-based products and services is closely linked to the knowledge and skills of users (companies or individuals). Thus governments can accelerate the dissemination of innovations through information campaigns and awareness-raising seminars and training courses on new technologies, and other similar initiatives to help equip consumers with the knowledge and confidence needed to adopt new innovative products and services. Typical examples are public campaigns to promote recycling, energy conservation, or prevention of certain diseases.

Given the large differences observed between industries, both in terms of their technological background and the mechanisms they use to articulate supply and demand, the most appropriate intervention level for demand-side innovation policies is the sectoral level. This implies the need to mobilise various ministries, departments or public agencies, with the mandate to regulate specific sectors among which energy, telecommunications, infrastructures, healthcare or defence stand out. Also relevant for the articulation of demand are consumer and competition policies. Ultimately, demand-side innovation policies require coordination between various ministries and public agencies, and between the government and the private sector, to set goals, shared visions and strategies for effective implementation of policies. Demand-side innovation policies should be directed to clearly articulated objectives, and their impact should be carefully evaluated because the empirical evidence yields mixed results and reveals that the impact of demand-side policies on innovation depends largely on the context (Edler, 2013).

While demand-side innovation policies are important, they will only be effective if local firms improve their technological capacity to respond to demand. While, as argued in previous chapters, some local firms can be considered technological leaders, in general terms most local firms lack the necessary STI capabilities to benefit from the new opportunities that will arise with the development of new sources of public and private demand, both local and external. In addition, most companies have limited access to information and it is likely that many of them would be unable to successfully adapt to the international norms and standards that must be complied with to participate in the export market. Therefore, demand-side policies, like regulatory changes and innovative public procurement, must be accompanied by other programmes that promote learning and skills development in firms, and should also consider the international dimension, seeking mechanisms to benefit from international trade and foreign direct investment as gateways to knowledge. It is also important in this process to take into account the size of companies and their potential for internationalisation.

**Public procurement as a tool to foster innovation**

Public procurement is considered the most important instrument of demand-side innovation policy (OECD, 2011). Indeed, beyond the goal of providing high-quality public services at the lowest possible cost to the taxpayer, public procurement may also pursue other objectives such as social inclusion, sustainability, local job creation, collaboration between companies, and support to small businesses or, indeed, promotion of innovation.
Innovative public procurement can improve the delivery of public services while promoting technological capacity-building in firms. Given the high volume of spending on public procurement\textsuperscript{53}, governments can act as a lever for business innovation and may also exert a signal effect as lead users that influence the process of dissemination of innovation. Innovative public procurement can strengthen the competitive position of suppliers by providing them with a local launch market, which can later facilitate their expansion into other markets, including other governments and the private sector, both nationally and internationally. \textsuperscript{54} Moreover, public procurement can also be used as a mechanism to attract innovative foreign companies, which not only allows improving public services, but also fosters the transfer of knowledge to the local production fabric, both through the collaboration of those firms with local businesses and through the experience acquired by the local workers employed by such foreign companies.

Different types of public procurement can be identified according to how they affect innovation (OECD, 2011):

- **Regular public procurement**: the public sector buys goods or services available on the market, so the prior execution of R&D activities by the supplier is not required. However, such regular purchases can act as instruments of technology policy when the tender includes specifications that prioritise innovative firms and projects.

- **Technology procurement**: purchase of ready-to-use goods or services that do not exist in the market but can be developed in a reasonable period of time through a previous R&D effort to meet the requirements of the buyer.

- **Pre-commercial technology procurement**: procurement of R&D services where public buyers do not keep the results of the R&D for their own exclusive use, but share the business risks and benefits inherent in carrying out the R&D activities required to develop innovative solutions that outperform the alternatives available in the market. In this case, there is no guarantee that the result of the R&D effort is going to be satisfactory, nor is there any assurance that, if satisfactory, the government will buy the product developed, although there is often a commitment that they will.

- **Catalytic public procurement**: in this case the government is involved in the purchase and may even start the procurement process, but the end user of the innovation acquired is the private sector. This category could include any of the three types mentioned above.

Moreover, it is also possible to distinguish between *development* and *adaptive* public procurement (Uyarra, 2010). In the first case, public procurement involves the development of completely new products or processes, whereas in the second case it involves the adaptation of existing products to the local context, i.e. it refers to products/services that are not new to the world but rather new to the country/region. In general, this second modality is more prevalent in less developed countries and regions, which rarely operate at the cutting-edge of knowledge. However, adaptive public procurement also provides opportunities to foster innovation in local companies, and to introduce incremental improvements that increase product quality and reduce costs.

\textsuperscript{53} Public procurement accounts for an average of 16\% of GDP in OECD countries. This figure tends to be even higher in developing countries (OECD, 2011, p. 80).

\textsuperscript{54} For example, a recent study in the UK of a sample of 800 companies (Georghiou et al., 2013) showed that over 75\% of companies that had developed innovations for the public sector stated that this had helped them gain new contracts with other public sector clients. Additionally, over 50\% of them experienced an increase in their sales to the private sector; and about 29\% recorded an increased in exports.
Considering that usually more than half of public procurement is implemented at the sub-national level (OECD, 2011), it is essential to better integrate innovative public procurement practices in regional and local strategies. Studies that have compared the local dimension of demand-side innovation policies with national initiatives (Lember et al., 2007; Uyarra, 2010) unveil that regions and cities face some additional challenges, such as the smaller size of the market; the reduced availability of local companies that can participate in the processes of innovative public procurement; the lack of autonomy and dependence on the central state in terms of legal and financial regulations; and an increased risk of corruption due to their smaller size and the close ties between those who hold political and corporate power. Moreover, developing countries like Colombia face some additional challenges when using public procurement as a mechanism to promote innovation, including the limited capacity of the government to implement this type of programmes (Kattel and Lember, 2010).

### Key policy issues

The current juncture and the increase in the public funds available to boost innovation opens new windows of opportunity for the development of public policies aimed at promoting demand for innovation in Medellin. These opportunities are associated with the confluence of three major trends:

- The ambitious transformation of Medellin into a “smart city.”
- The deployment of Medellin's STI Plan with its emphasis on energy, health and ICT clusters; and the emerging shift towards a smart specialisation strategy based on enabling technologies.
- The need to promote new inclusive and social innovation policies, aimed at meeting social needs such as environmental protection, social housing or access to education, among others.

### Promoting an innovative culture

To promote the demand for innovative goods and services, both citizens and firms need to advance towards the adoption of a more innovative culture. As noted above, governments can support this process through various initiatives designed to provide information and mobilise the interest of consumers and businesses for new technologies. Such initiatives include information and awareness-raising campaigns, and organising seminars and training courses, among others.

In Medellin, Ruta N's Directorate of Innovation Culture is currently the organisation in charge of promoting a more innovative culture that will lay the foundations for social change. Their goal is to increase the interest in and knowledge of science and innovative technology among young people and society in general. They also wish to reach the most disadvantaged segments of the population, organising public events, providing free courses, and offering learning spaces, be it through the city’s network of libraries or science museums such as Explora Park.

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55 A "smart city" can be defined as that which employs technological advances to improve the quality of life of its citizens and promotes sustainable growth. This concept is becoming increasingly popular worldwide and is also inspiring Medellin’s urban transformation, as evidenced by the Medellín Ciudad Inteligente programme (http://estrategia.medellin.co/estrategia/).

56 Medellin’s library network offers free internet access at its 27 facilities distributed throughout the city. There, citizens can browse electronic publications, take online courses and access other resources (http://www.reddebibliotecas.org.co/sistemabibliotecas/Paginas/default.aspx).

57 Explora Park is a museum, aquarium and planetarium established in 2007. It was conceived to encourage the appropriation of scientific and technological knowledge by a heterogeneous audience through a series of interactive areas and exhibitions, which aim at promoting an environmentally friendly scientific and civic culture for a better society. (http://www.parqueexplora.org/).
de Ingenieros programme, through which engineering students are encouraged to propose solutions to the most urgent challenges of the city. In the first pilot in 2013, after a training course provided by Ruta N, students suggested ways to decrease the time spent and the difficulties encountered when using public transport by citizens of the neighbourhoods on the hillsides, which have grown considerably in recent years and are home to the most deprived groups in the city.

Ruta N's Directorate of Innovation Culture constantly organises seminars, conferences and courses of various kinds to meet its objectives. It also offers innovation awards to make the progress achieved more visible to society, while motivating entrepreneurs and companies to develop new innovative projects. These efforts are complemented by other initiatives developed by the Chamber of Commerce of Medellin, such as the Alliance for Innovation in Antioquia project, which is a project developed jointly with government agencies Colciencias and SENA with the purpose of building basic skills in innovation management in micro, small and medium enterprises in the regions of Antioquia, facilitating the generation of an innovation culture and reinforcing the connection between supply and demand for innovation.58

The national initiatives aimed at strengthening an innovation culture are also noteworthy. A good example is the Ondas programme developed by Colciencias since 2001 with the aim of contributing to the promotion of a scientific culture among young Colombians (Lozano, 2013). Innpulsa has also developed, since 2012, a wide range of activities including events, forums, visits of innovative entrepreneurs, social networking sessions and awareness-raising campaigns, aimed at promoting an innovative and entrepreneurial culture. It would be advisable to seek greater coordination between local, regional and national initiatives to avoid overlapping and duplication, improving the efficiency of public interventions.

**Colombia Compra Eficiente**

In 2013 new public procurement regulations entered into force, following the creation in 2012 of a new central procurement agency called Colombia Compra Eficiente.59 This new development has been accompanied by the publication of manuals and guidelines to enhance the procurement process, aimed at both government departments and bidding companies. The underlying goal is to improve transparency, fight corruption, strengthen competition, ameliorate the efficiency of processes and the use of online platforms, modernise legal and control systems, and promote technical assistance to regional firms wishing to participate in public procurement procedures (OECD, 2013).

However, the new guidelines make no explicit reference to innovation, so it would be important to analyse how to better integrate the aim of promoting innovation into the new public procurement regulations. In this regard, the recent OECD Review of Colombia's Innovation Policy (OECD, 2014) recommends encouraging public organisations to develop R&D activities in the private sector, through independent projects to meet public needs or as explicit components of contracts for the ordinary purchase of goods and services.

**Public procurement in Medellin**

Public procurement in Medellin is governed by the state procurement rules, under the umbrella of the Colombia Compra Eficiente national framework. All bids must be entered into the Single Procurement Portal and advertised in the newsletter of the Chamber of Commerce of Medellin and the local press. Moreover, the City Council website contains all applicable regulations, relevant news, examples of

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58 Further information at: http://www.camaramedellin.com.co/site/Cluster-y-Competitividad/Proyectos-Empresariales/Alianza-por-la-Innovacion.aspx

59 Further information at: http://www.colombiacompra.gov.co
successful procurement and other useful tools to assist bidding companies. Medellín’s Public Procurement Handbook is another useful tool that gathers all regulations and procedures, including detailed information about the procedures followed to draft specifications and select proposals. 60 One of the explicit goals of municipal procurement is to encourage the participation of SMEs and “social and community organisations.” In some types of projects, it is mandatory that at least 80% of the unskilled personnel required for the execution of the contract is recruited among the residents of the community where the contract is to be performed. The City Council also offers training courses to encourage SMEs to learn the procedures and participate in the opportunities offered by public procurement. To facilitate participation of SMEs, the local government has simplified administrative processes and improved payment conditions and access to information.

The urban and social transformation of Medellín has been orchestrated by its City Council through public procurement in the framework of investment projects that have substantially contributed to the city’s innovative drive (see Box 21). However, as in the rest of the country, public tendering procedures are heavily regulated and no mechanism has been defined to include innovation-related criteria. The words innovation or research are not mentioned even once in Medellín’s Public Procurement Handbook, described in the previous paragraph.

60 Medellín’s Public Procurement Handbook was published in 2013 and can be downloaded at the following link: http://www.medellin.gov.co/irj/go/km/docs/wpcontent/Sites/Subportal%20del%20Ciudadano/Contrataci%C3%B3n/Spciones/Publicaciones/Documentos/2013/Manual%20de%20Contrataci%C3%B3n%20del%20Municipio%20de%20Medell%C3%B3n%202013.pdf
Box 21. Public investment in social innovation in Medellín

During the last few years some major successful infrastructure investments have been made, which in fact are the main factor behind the designation of Medellín as Innovative City of the Year 2013 by the Wall Street Journal, the Urban Land Institute and Citigroup. Although these investments were not explicitly conceived under the umbrella of an innovative public procurement initiative, they have de facto introduced innovations both in the environmental and social domains. On the one hand, new public transport infrastructures such as the Medellín underground system and the Metropolip gas-operated bus system have improved the mobility of citizens and substantially reduced CO2 emissions. Moreover, solutions have been developed to better integrate the most vulnerable areas of the city, such as the escalators in Comuna 13 or the first Metrocable cable railway in the city, developed to service comuna Popular, one of the most violent neighbourhoods in the city that has now become more quiet and easily accessible to its residents, and even a tourist attraction. Other public projects aimed at the inclusion of disadvantaged neighbourhoods include the library parks, the Moravia Cultural Centre, or the Sendero de la Pacificación (Path of Peace), among others.

Ongoing investments within Medellín’s urban development plan include the Medellín innovation district and other relevant projects such as the Ayacucho tram, which will be connected to the underground system and will have two overhead cables that reach the Sierra and 13 de Noviembre neighbourhoods, and the north bridge that will connect the comunas of Aranjuez and Castilla. Also noteworthy is the Park around Medellín river for which an international design competition was launched. Moreover, a green belt is projected in the higher areas of the city that will include footpaths, housing, and public spaces. Another relevant example in this context is EnCicla, the new public bike system of Medellín, which will be expanded in 2015 following completion of the pilot phase.

In recent years, Ruta N has launched a number of public contests closely related to innovation. Among them, Mi Medellín programme has created an inclusive, transparent and open space where citizens can contribute their ideas on how to solve the challenges faced by the city. To date, more than 2,500 citizens have provided their input on how to address a variety of challenges. Up to now, the challenges and questions have been defined by the organisers of the programme, based on interactions with the community. However, the idea is that the portal should evolve into a space where citizens themselves can also propose challenges that should be given priority. Some of the questions posted at the closing date of this Review were: What would you do to improve our quality of life? What do you think could be the next challenge for the city? How do you dream Medellín’s downtown? How would you improve mobility in Medellín? What do we need in Medellín to be better citizens? Some others went into greater detail: How would you bring life to the areas below the crossing bridges over river Medellín? And, how would you solve the issue of street vendors?

Although this initiative by Ruta N is interesting, it is still at a very early stage. If it is to be successful in the future, all efforts aimed at increasing citizen participation should be intensified so that the programme can become a bottom-up public procurement initiative. In this respect, another initiative exists in Antioquia that may serve as inspiration for extending the Mi Medellín programme, in addition to representing an interesting example to other regions of the world (see Box 22).

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61 All of these public tenders can be found on Ruta N’s website: http://rutamedellin.org/index.php/es/sobre-nosotros/informacion-sobre-rutan-medellin/contrataciones-publicas-rutan/3

62 Further information at: www.mimedellin.org
Box 22. ¿Quién se le mide? programme

The ¿Quién se le mide? (Who's up to it?) Programme, promoted by the Governorate of Antioquia and managed by Tecnova, is intended to test the creative and innovative potential of university researchers, research fellows, technology development centres, firms and students. It is a small-scale programme that consists of a contest to solve some of Medellin's everyday problems. A series of urban challenges are proposed, which usually require small-scale technology to be resolved, and the best solutions of all proposals received are selected. Proposals should provide functional and feasible solutions. Product development, improvement of production processes, creation of new innovative enterprises and even improving social conditions in the region of Antioquia are all objectives of this Programme. The programme can be broken down into three phases: 1) formulation of the challenges; 2) evaluation and selection of the winning proposals; 3) support and follow-up of winning proposals.

In the first edition of the programme, in 2013, 20 challenges were selected by the government out of a list of 90 challenges that came out of consultations with different government departments, technology foresight analyses, and a prioritisation exercise. A total of 1651 proposals were submitted. For illustrative purposes, some of the challenges in the first round were the following:

- Manual device for picking avocados at different heights
- Solar dryer for medicinal and seasoning herbs
- Gas-operated cocoa bean dryer.
- Mobile citrus fruit processing plant, mounted on a container.
- Portable spectrometer to determine avocado ripeness
- Smartphone application for collecting technical information on specialty coffees.
- Bottle holders used to certify the authenticity of Antioquian aguardiente and rum.
- Tool for identification and destruction of landmines.
- Community water purification system for the municipalities of Antioquia.

Following the success of the programme's first edition, a second edition was launched in April 2014, which also poses 20 challenges in 7 priority areas: Agriculture, specialty coffees, infrastructure, the environment, mining, health and social welfare. The winning solutions will obtain COP 15, 25 or 35 million, depending on the complexity of the solutions proposed. Thus, the total budget for 2014 amounts to COP 490 million (about USD 245,000), which is a reflection of the small scale of the programme.

In any case, this has been a successful initiative that illustrates the potential of public procurement in promoting social innovation, and could serve as an example to other regions of Colombia and the world. According to Alejandro Franco, CEO of Tecnova, three key lessons were learned from the first edition of the programme. First, the need to support public officials in the formulation of the challenges, as they are often too busy to devote sufficient time to this matter. Secondly, the programme needs to be further disseminated so as to increase the number of proposals. And third, support to the winners is critical so that they make proper use of the award.


Corruption as a barrier to innovative public procurement

Some of the principles of innovative public procurement may hinder free competition as well as transparency in the selection of projects on the basis of objective and quantifiable criteria. This may in turn increase the risk of corruption. These factors are particularly relevant taking into account the seriousness of
the political corruption problem in Colombia. Indeed, the country ranked last among Latin American countries in Transparency International’s 2013 Corruption Perception Index, with no improvements having been observed in recent years. Other international surveys and reports (see for example Lehuedé, 2013) also affirm that the corruption problem has not been solved despite recent developments such as the adoption in 2011 of the Anti-corruption Statute or the creation of a presidential anti-corruption office. One of the areas where corruption of the political class manifests itself more clearly is public procurement, in situations where either bribes are accepted or the interests of relatives and friends are promoted (Martínez and Ramírez, 2006). Therefore it is essential to strike a balance between the greater flexibility that is necessary to foster innovation through public procurement and the prevention of the risk of corruption by transparent and continuously monitored procedures.

Vive Digital Plan

The Vive Digital plan, sponsored by Colombia's ICT Ministry, provides an interesting example of how to articulate demand-side innovation policies, providing users incentives and subsidies to encourage the adoption of new innovative ICT products. The ultimate goal of this programme is to narrow the digital gap, making it possible for the most disadvantaged populations of the country to access new technologies. The Vive Digital plan comprises information campaigns, training courses and public investment programmes aimed at expanding the use of optical fibre, distributing computers and tablets so that every citizen in every municipality can connect to the internet. One of the objectives of the programme is to donate, by the end of 2014, 66,900 computers and 1,132,000 tablets to schools in the most deprived municipalities and neighbourhoods of the country. In addition, two kinds of free-access internet centres, Vive Digital stations and smaller Vive Digital kiosks are being built to encourage internet use among the most disadvantaged citizens. Moreover, new tax incentives for the purchase of computers and tablets were introduced in 2011 (exemption from VAT and customs duties). All of these initiatives stimulate the demand for innovative products and services associated to digital technologies and, at the same time, help narrow the digital gap between the country’s rich and poor.

FTAs

Following many years of negotiations, in 2013 new Free Trade Agreements (FTAs) entered into force between Colombia and the United States and the European Union. Colombia has also recently signed bilateral trade agreements with other countries such as Canada and South Korea, and significant advances are taking place in Latin American regional integration processes. This rapid liberalisation of trade opens up new export opportunities for Colombian firms, expanding their potential market, but at the same time it represents a new source of competitive pressure that may adversely affect some businesses and sectors, which will have to be restructured. FTAs constitute a stimulus to demand that drives Colombian companies to adopt innovative solutions to be able to compete. Another advantage of FTAs is that they allow the


65 Note the recent developments in the Pacific Alliance, a trade bloc composed by Colombia, Mexico, Chile and Peru. During the Alliance’s eighth summit held in Cartagena, Colombia, on 10 February 2014 the Member States agreed to suppress custom duties for 92% of the goods and services traded between them. In this way, this region can be considered a successful regional integration model, attracting the international community’s attention and raising great expectations (Reyes, 2014).
acquisition of capital goods at lower prices, which promotes the absorption of the new technologies embedded in the machinery and equipment acquired (Hendricks, 2000).

**SWOT analysis**

Based on the diagnosis above, Table 13 presents a summary of the strengths, weaknesses, opportunities and threats that serve as a basis for analysing demand-side innovation policy in Medellin.

Table 10. SWOT analysis

<table>
<thead>
<tr>
<th>Strengths</th>
<th>Opportunities</th>
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<tbody>
<tr>
<td>● Recent efforts to promote an innovative culture.</td>
<td>● Ambitious public investment projects for the coming years aimed at reinforcing the city's innovative profile.</td>
</tr>
<tr>
<td>● Success of Medellin's urban transformation during the last decade</td>
<td>● Greater openness to international trade under the new FTAs.</td>
</tr>
<tr>
<td>● Participation of the business sector and civil society in contests for innovative solutions such as Mi Medellín and ¿Quién se le Mide?</td>
<td></td>
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<table>
<thead>
<tr>
<th>Weaknesses</th>
<th>Threats</th>
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<tr>
<td>● Lack of a clearly-defined regulatory framework for innovative public procurement.</td>
<td>● Corruption problems may stand in the way to the development of a new innovative public procurement programme.</td>
</tr>
<tr>
<td>● Limited use of regulations and standards as instruments to foster innovation</td>
<td>● The large majority of firms in Medellin are small and lack the technological capabilities required to take full advantage of demand-side innovation policies.</td>
</tr>
</tbody>
</table>

**Recommendations**

Demand-side innovation policies can make a very significant contribution to achieving the four strategic priorities discussed in Chapter 1. Indeed, demand-side policies make it possible to more clearly orient the technology-related priorities of the city toward social innovation, as well as towards a series of cross-cutting technologies to be defined as priorities in the context of a new smart specialisation strategy. In the articulation of a strategy based on demand-side policies proper multilevel governance is necessary, where synergies between local, regional and national governments are sought. Finally, it is also important to orient demand-side policies toward internationalisation, particularly in the light of the recent FTAs between Colombia and the United States and the European Union.

**A new innovative public procurement programme for Medellin**

Considering the diagnosis made in this chapter, the main recommendation would be to develop a new innovative public procurement programme to help achieve greater coordination between innovation policy and social needs. A first issue to consider would be whether the initiative should focus on the municipal level or include the entire region of Antioquia in a joint initiative. It is also critical to consider how to link this new initiative with the national public procurement programme. Moreover, it would be important for local public companies like Metro and EPM to be included in the programme as their size and nature could provide - and indeed they are already providing - a significant boost to demand-side innovation policies.

A first step could entail appointing, within Ruta N, a working group and a person responsible for leading efforts to develop a guide or an operational manual, after consultation with the departments and administrative units that more regularly buy innovative products and services and in coordination with the Undersecretariat for Procurement and Contractual Performance of Medellin City Council. As this manual
would apply to all municipal offices, it should be general and flexible enough to integrate the specificities of the different secretariats. In a second phase, an awareness-raising, education and training programme aimed at both the public administration and to potential and existing contractors should be implemented. The annual Departmental-Municipal Public Procurement Fair would be a good platform to start introducing the debate on innovative public procurement and on how to disseminate the manuals that are eventually developed.

When setting priorities for action it is necessary to clearly define what social needs are to be met and how an innovation approach to public procurement can contribute to overcoming market failures or systemic failures that hinder innovation. It is essential to consider at all times whether public intervention is efficient from the point of view of the market and the budget, and if it enhances social welfare. Moreover, when selecting projects it is important to assess the extent to which participating companies will be able to develop technological skills and obtain new benefits from the products and services developed through their application in other public and private spheres, either in Medellin or in other cities and countries. This indirect business development potential should be considered when deciding what kind of projects should be a priority and should be encouraged throughout the lifecycle of the public contract. In short, demand-side innovation policies should be directed towards clearly articulated objectives, and their impact should be carefully evaluated throughout the lifecycle of the programme.

The experience accumulated in OECD countries (European Commission, 2007; Georghiou et al, 2013. OECD, 2011; OECD, 2012) makes it possible to extract some general recommendations that may be useful to guide innovative public procurement policies in Colombia and Medellin. Such recommendations include:

- Integrate innovation-criteria in public procurement processes and introduce mechanisms so that all departments and public agencies take these criteria into consideration. For example, in the UK a requirement introduced in 2008 that all ministries establish an innovative public procurement plan provided an opportunity to rethink how innovation could be stimulated by ameliorating public procurement processes (OECD, 2011).

- Provide necessary training to public officials responsible for public procurement (through training courses, experience exchange programmes, manuals and action guides, etc.). Collaboration between ministries or departments should be encouraged to promote mutual learning and streamline procedures, for example by encouraging the use of common documents in public tenders.

- Improve the exchange of information and public-private coordination in order to alert buyers of new technological solutions and providers of new business opportunities, thus promoting a shared vision between government and the private sector on future priorities and directions. The mechanisms that can be used for this purpose include technology platforms; expert groups and competitive intelligence; and technology foresight and surveillance tools. In this context, the case of the Belgian region of Flanders is illustrative (See Box 23).

- Use a competitive dialogue process for particularly complex procurement processes, which would involve shortlisting a small group of potential suppliers who could help the authorities better define the most appropriate solution that will subsequently be integrated into the specifications of the tender.

- The specifications of the bidding process should establish functional specifications indicating the specific public needs to be satisfied by the product or service required, but without defining the
formulas that must be used to meet those needs. This will allow bidding companies to submit different options, extending the proposals’ innovative potential.

- Contracts should be flexible enough to allow further changes after the contract has been awarded. Indeed, new opportunities for improvement or incremental innovation may arise both during the development phase and during the implementation of the new product or service.

- Patents and other intellectual property rights generated as a result of innovative public procurement should be left in the hands of suppliers, and the government should not interfere in their subsequent exploitation elsewhere. This is vital to promote the dissemination of innovative products and services so as to take full advantage of their market potential.

- Given the risk inherent in R&D activities and the risk aversion that usually characterises government, it is important to establish mechanisms for risk assessment and control as part and parcel of the various phases of public procurement.

Box 23. The innovative public procurement programme of Flanders, Belgium

In 2009, the regional government of Flanders launched an innovative public procurement programme. This pre-commercial programme consists in a sequential process whereby selected companies or R&D centres must develop innovative products, services or processes, that do not exist in the market, and which may help address major social challenges. In the first instance, 13 priority areas were selected, and EUR 1 million was assigned to each of them to carry out pilot projects for an initial period of two years. For each selected project, an “innovation platform” was established with the aim of coordinating market consultations and technical discussions between the public purchaser and participating companies and R&D centres. The first thing these platforms had to do was conduct a review of the state of the art, explore the solutions available in the market and determine whether additional R&D was necessary.

For more information see the complete description of the programme in Annex A.

It would also be advisable for innovative public procurement procedures to establish mechanisms to encourage the participation of SMEs, in the same way as their participation is encouraged in the framework of Medellin’s regular procurement system, as was discussed above. Incentives to stimulate SME involvement in innovative public procurement processes are important because these firms face greater difficulties than large companies but can be equally innovative, and can also make it possible for the benefits of innovative public procurement to be more evenly distributed across the different actors of the local business community. The government can use public procurement processes as a tool to promote collaboration between companies as well as the establishment of innovation partnerships, for example by giving extra points in public tenders to proposals submitted by consortia that include a medley of small and large companies.

For example, an innovative public procurement programme that pioneered support for SMEs was the American "Small Business Innovation Research" (SBIR) programme, dating back to 1982, which requires government departments involved in R&D (Department of Defence, NASA, NIH, DOE, etc.) to assign at least 2.5% of their R&D contracts to SMEs. It is a pre-commercial public procurement programme, the first phase of which is publication by the government of an open round of applications where they expound their specific needs. Subsequently, a group of companies is selected, which receive USD 100,000 each to carry out a pilot over a period of six months. In the second phase, a smaller group of companies is awarded

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Further information at: http://www.sbir.gov/
USD 750,000 each and given two years to carry out the fully-fledged R&D project. The third phase is the go-to-market phase where companies no longer receive funding from the programme, but can receive funds from other public programmes or private funds. Currently the programme has an annual budget of USD 2 billion, with more than 4,000 grants awarded every year, most of them to companies with fewer than 25 employees. The programme was so successful that it has been replicated by other OECD countries such as Australia, UK and the Netherlands (OECD, 2011).

Another priority is to discuss the strategic treatment to be given to foreign companies that participate in public tenders. On the one hand, the tendency to give priority to local suppliers is based on the protection of local industry in the framework of policies aimed at substituting imports to boost endogenous development (Trionfetti, 2000). However, this bias could exclude more innovative and efficient solutions available abroad, and block other potential indirect regional benefits associated with the entry of foreign companies and technologies. In addition, the leeway to favour local companies has been reduced with the recently signed FTAs with the USA and the EU, and it is likely that in the future Colombia will join other multilateral treaties that will limit further possibilities of favouring local companies in public tenders. Although the local government of Medellin will do well to keep favouring local suppliers when it deems it appropriate to promote endogenous development, it should also consider ways to attract foreign companies to provide more advanced technological solutions that those available locally, always striving to ensure the local impact of such solutions. A potential strategy in this context would be introducing requirements that encourage foreign bidders to settle in the region and hire local employees to develop their projects or establish partnerships with local companies/universities. This type of policy measures could be linked to the promotion of corporate social responsibility programmes in the framework of the OECD Guidelines for Multinational Enterprises. Moreover, to ensure the participation of foreign bidders it is important to establish international promotion channels and actively seek international companies that may be of special interest. These considerations are relevant in the context of the strategies to attract foreign innovative companies that are discussed in Chapter 6.

Despite the many advantages of policies aimed at promoting innovation through public procurement, many challenges and barriers exist that hinder their implementation. First of all, note should be taken of the bureaucratic complexity and fragmentation of public demand between different ministries, public agencies and levels of government. Secondly, it is not easy to achieve balance and consistency between the different objectives of public procurement. Promoting innovation must be compatible with the need for efficient and transparent public procurement procedures that do not disrupt competition. Ministries and public agencies have a duty to minimise the cost of public services to the taxpayer, and ensure that all applicants (including foreign companies) get a fair and equal treatment. Third, the uncertainty and risk inherent in R&D activities complicate planning and identification of the most appropriate solution. Innovative public procurement must from an early stage identify future needs and make sure they are met by future supply, but there is a risk of imperfect assessment of future scenarios due to technological knowledge asymmetries between supply and demand. In particular, governments often lack the necessary knowledge and skills in the relevant technological domains. Moreover, although identification of needs and technologies may have been successful, there is no guarantee that existing suppliers will be able to meet this demand in the future. Therefore, designing innovative public procurement strategies requires attention to these risks, using methods and tools to mitigate them (European Commission, 2007).

67 The most important one is the Government Procurement Agreement (GPA) of the World Trade Organisation (WTO), based on the principles of non-discrimination, transparency and procedural fairness. At this moment, Colombia is a non-member observer State, so it is not bound by the agreement.

68 See in particular Chapter IX on Science and Technology, which establishes, among other guidelines, that multinational companies should perform scientific and technological development in host countries, including hiring and training of science and technology personnel to address local market needs: http://www.oecd.org/daf/inv/mne/MNEguidelinesESPAÑOL.pdf
Box 24. Innovative public procurement in the EU and Spain

In recent years, the European Union and its member countries have been paying increasing attention to public procurement as a tool of its innovation policy. In particular, the so-called Lead Market Initiative (2008-2011) promoted the use of public procurement as a tool to achieve a leadership position in six markets classified as vital to the development of the European economy. More recently, the Horizon 2020 programme, which provides EU funding for R&D and innovation for 2014-2020, contemplates among other instruments increased resources for innovative public procurement, either in the form of pre-commercial or technology-based public procurement, to be implemented by the European Commission alone or jointly with Member States.

In line with these developments in the EU, the Government of Spain launched a new package of measures to boost innovative public procurement in July 2011. All departments and agencies must earmark a portion of their budget for innovative public procurement, which may be pre-commercial or technology-based public procurement. The Government's aim was to increase spending on innovative public procurement to 3% of the national budget by 2013. Three instruments have been developed to implement this initiative:

- **User-guide on Innovative Public Procurement**: the purpose of this guide is to provide public bodies and private businesses information on the tendering and award procedures that govern innovative public procurement.
- **Innodemanda programme**: this is a funding instrument aimed at supporting companies and research centres that participate in innovative public procurement processes.
- **Innocompra programme**: provides co-funding from national and European funds to regional governments wishing to develop innovative public procurement projects.

The experience of Spain, and in particular the User-guide on Innovative Public Procurement, can be an interesting example for the development of a new innovative public procurement system in Colombia and Medellin, especially because contents are written in Spanish and reflect European best practices.

For further information on innovative public procurement in Spain:
[http://www.idi.mineco.gob.es/portal/site/MICINN/menuitem.7eeac5cd345b4f34f09ddf1001432ea0/?vgnextoid=d7e6c3f020682310VgnVCM1000001d04140aRCRD](http://www.idi.mineco.gob.es/portal/site/MICINN/menuitem.7eeac5cd345b4f34f09ddf1001432ea0/?vgnextoid=d7e6c3f020682310VgnVCM1000001d04140aRCRD)

For further information on innovative public procurement in the EU:

Other recommendations for demand-side innovation policies

- **Explore areas where municipal regulations, such as housing industry standards or incentives to the use of renewable energies, can influence the private demand for innovative products and services.** As far as standards are concerned, the technological surveillance role of the municipal government could be strengthened so that it can act as a facilitator or coordinator, collaborating with universities and business associations to inform companies of international standards and the expected changes thereof, and possibly organise or sponsor awareness-raising campaigns and training courses on the international standards applicable to the strategic sectors of the region. This type of action is particularly useful to maximise the opportunities for increased exports provided by the new FTAs with the USA and the EU.

- **Develop programmes to orient specific industries towards the needs of the markets,** assisting them in seeking new export and specialisation opportunities for the region's products in niche markets that offer the greatest potential to add value locally. An interesting example that is
already underway is the Governorate of Antioquia’s specialty coffee programme for the period 2012-2015.”

- **Propose new initiatives to promote green technologies.** Some common initiatives in OECD countries, which are equally relevant to Colombia and Medellin, are the incentives for the promotion of renewable energies; the use of low-consumption light bulbs; the transition to electric cars, sustainable public transport, building insulation for saving energy, etc. For example, in Germany the Law for the Promotion of Renewable Energies of 2009 stipulates that new buildings must use renewable energies and provides for state funding for particularly efficient buildings that use innovative technologies. Also the Autonomous Province of Trento in Italy has recently introduced incentives for the use of renewable energy in new buildings, including solar panels. The Swedish city of Malmo provides another interesting example of the use of innovative public procurement for their strategic sustainable urban development plans.

- **Ensure that companies participate in and benefit from online government programmes.** Use of online government tools improves the quality of citizen services, reduces bureaucracy and increases transparency. At the same time, it provides an opportunity to promote innovation in ICT companies selected as providers of networks and applications. In addition to the adoption by Medellin City Council of new e-government applications, Medellin’s ICT businesses can also step up their participation in the recent online initiative by the National Government whose priority areas are health, justice, cybersecurity, citizen services and government IT architecture. It is envisaged that these programmes will expand substantially in the future (OECD, 2014), which will lead to new opportunities for companies in the sector.

- **Create programmes to support companies so that they can benefit from the new FTAs.** The new FTAs with the USA and the EU create new ways to improve national certification schemes and promote technical cooperation for the adoption of international standards, which is a stimulus for Colombian firms to engage in innovation. In this regard, before the entry into force of the FTAs a number of companies and business associations in Colombia, and particularly in Medellin, benefited from technical assistance funded by cooperation programmes with the EU and the USA. Such assistance was aimed at improving their processes to be able to cater for the needs of

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69 This programme intends to support the region’s coffee producers in improving the quality of production processes and environmental standards in order to better position the brand image of Antioquian coffee with a view to taking advantage of the growing global demand for specialty coffee. The project is also linked to the development of a new coffee tourist route: [http://antioquia.gov.co/index.php/cafes-especiales-el-programa/13549-antioquia-tendra-marca-propia-de-cafe](http://antioquia.gov.co/index.php/cafes-especiales-el-programa/13549-antioquia-tendra-marca-propia-de-cafe)

70 In January 2014, the National Government launched a set of measures to promote the use of electric cars. One of the measures makes it mandatory for the government to buy only electric cars thereafter. Other measures include encouraging Transmilenio and the Integrated Public Transport System (SITP) to incorporate electric buses to their networks. Medellin could also look for ways to implement similar initiatives at local level.


72 Further information at: [http://www.malmo.se/download/18.228b8e2313f81626274842a/1383649557361/susmalmo2013_fickis_web130424.pdf](http://www.malmo.se/download/18.228b8e2313f81626274842a/1383649557361/susmalmo2013_fickis_web130424.pdf)

73 Medellin City Council has recently launched a competition to develop a new integrated internet platform for mobile applications, which will reshape the relationship between the local government and citizens in all areas. The first stage, won by EAFIT University, was a contest to design the architecture of the website. A second phase, which consisted in developing the platform from the specifications defined in the first stage, was awarded to local company UNE. This experience could be replicated by EAFIT and UNE in the future in other Colombian and Latin American cities and regions.

the United States and European markets, thus increasing their exports across various sectors including clothing and textiles, agriculture and livestock-raising. Moreover, public agency Proexport (under the Ministry of Commerce, Industry and Tourism), whose functions include the promotion of Colombian exports, has recently launched information programmes and campaigns intended to publicise the implications of the new FTAs, and ensuring that Colombian companies can take full advantage of the opportunities that these agreements offer. Further, these programmes should be properly disseminated in Medellin and the rest of Antioquia, looking for ways to support the efforts of Proexport with local initiatives.

- Encourage universities in Medellin to develop e-learning platforms and programmes. This would allow making public education available to a large number of youngsters living in disadvantaged areas of Medellin and the rest of the Antioquia region, with a focus not only on higher education but also on vocational training, and continuous training of the workforce. In addition to its potential to develop human capital in the region, e-learning could open new business opportunities for companies in Medellin that are able to market these technological and educational contents to the rest of the country and other Spanish-speaking countries. The local government could explore methods to increase public funding for such initiatives through public tenders by subject areas, fostering collaboration between universities, research groups and companies in the ICT sector.

- Improve the integration of Ruta N’s My Medellin platform with public bidding processes so that results do not remain at the prototype stage but are put into practice. In short, the idea would be to coordinate the actions of the My Medellin programme described above with the current priorities of the City Council, so that proposals are put into effect within a reasonable time frame, thus avoiding the citizen’s frustration at the slow pace of implementation. The Mi Medellín platform also represents a good opportunity to involve SMEs and the informal sector in innovative public procurement, as was the case at departmental level with the ¿Quién se le mide? programme described in Box 22.

- Use public procurement as a tool for modernising the public health system by incorporating modern equipment and new technologies and, in particular, ICTs to develop new tele-assistance platforms. This initiative could drive innovation and, at the same time, contribute to improving the quality of life of the population. As already mentioned, working in this area provides an excellent opportunity to better link Medellin’s innovation agenda with the needs of the rest of the Antioquia region and seek opportunities for collaboration with other regions.

- Consider creating new tax incentives for companies that purchase innovative products, capital goods, or technology services. In the last few years, Colombia has introduced some tax incentives that help foster private demand for innovative products, such as exemption from VAT and import duties for the purchase of computers and tablets under the Vive Digital plan of 2011. There is also an exemption from VAT on imported equipment and goods used in science, technology and innovation projects, which stimulates the demand for imported products that improve the productivity of domestic firms. It would be advisable to evaluate the impact of these incentives and, if appropriate, propose possible reforms and study the potential of extending these incentives to other product categories.

75 For further information, see the results of the European ICT for Health project at: http://www.ictforhealth.net/
CHAPTER 5: PUBLIC POLICIES TO PROMOTE DEMAND FOR INNOVATIVE PRODUCTS AND SERVICES

References


CHAPTER 6

STRATEGIES TO ATTRACT STI-INTENSIVE INVESTMENTS

There are many well-known instances of emerging economies that, at an early stage in their economic transformation, deployed active strategies to attract foreign direct investment. Thus, countries like Ireland, Singapore and Costa Rica are frequently cited as cases where policies aimed at attracting international high tech companies were successfully implemented (Agosín and Price, 2009).

Drawing on the examples provided by countries like those mentioned above, and in the face of the growing internationalisation of foreign investments intensive in knowledge, technology and R&D (Guimón, 2008), an increasing number of nations and regions from Europe, Asia and Latin America have realised that attracting global high tech firms, laboratories and internationally renowned R&D entities is an effective way of strengthening their local innovation systems and, at the same time, stimulate their own local economies. 76 Those effects are likely to be achieved, particularly through the energising effect that the establishment of those firms can have in terms of creating jobs for highly skilled workers; developing local suppliers for sophisticated segments of the value chain; and stimulating the demand for local capabilities in STI.

Moreover, according to the recently published “Ranking of the Most Attractive Latin American Cities for Investment” (Ránking de ciudades latinoamericanas para la atracción de inversiones, Universidad del Rosario, 2013), the specialised literature has revealed a progressive concentration of investments in the geographical area under analysis. 77 From a country-centred perspective (Porter, 1992) experts have moved toward an approach which increasingly focuses on comparisons between metropolitan areas, without totally abandoning comparisons between countries and regions. Current analyses show that cities such as Bangalore, Shanghai, and Kuala Lumpur; and Sao Paulo, Montevideo and Santiago de Chile in Latin America, are nowadays recognised destinations where global companies make significant STI-intensive investments.

Medellín has made considerable progress in this respect. In the last 10 years it has accumulated a wealth of resources related to the development of its innovation system, including: a widespread presence of universities, renowned R&D groups, high quality training of skilled human capital, and a local entrepreneurial base. These assets place the city in an advantageous position in both the national and the Latin American context as an attractive destination for both corporate and institutional STI-intensive investments (Escobar-Arango, 2013).

Although strategies to attract STI-intensive investments respond to models that differ from country to country, and even from region to region and from city to city, it is however possible to identify some components which, to a greater or lesser extent, are present in most of the experiences that have garnered

76 Hereinafter called “STI-intensive investment” or “high-tech investment.”
77 This report includes the relative assessment of the performance and attributes of the 48 most important Latin American cities for attracting both foreign and national investments in 2012. It also estimates their potential for expansion in 2013. Santiago de Chile and Sao Paulo lead the ranking, and Medellin is ranked 13th. It is worth noting that Medellin was ranked 25th in the previous edition of the report. In other words, Medellin was the city in the region that showed the biggest relative progress between 2012 and 2013.
some measure of success. These are: (i) international promotion and positioning; (ii) improvement of the critical local factors that influence investors’ decisions; (iii) support to investors; and (iv) an incentive policy to formalise and retain high tech investments. As regards city-specific strategies, each one of these components entails a combination of specific nationwide policies, generally promoted by city councils and local investment promotion agencies, with international initiatives. Efforts to enhance multilevel governance are therefore crucial in this realm in order to facilitate the development of the local innovation system.

In the case of Medellin, plans, institutional actions and specific incentives exist within each of the four areas mentioned, as can be seen in the summary presented in Table 14.
Table 11. Key factors in Medellin’s strategy to attract investments in STI

<table>
<thead>
<tr>
<th>Strategic goals</th>
<th>Plans, incentives and main actions</th>
</tr>
</thead>
<tbody>
<tr>
<td>International promotion and positioning of Medellin.</td>
<td>• Building Medellin’s reputation as an innovative city by disseminating the city’s success story in international fora, conferences, seminars, institutional and trade missions. International recognition as a paragon of social innovation</td>
</tr>
<tr>
<td></td>
<td>• Obtaining international recognition and awards</td>
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<tr>
<td></td>
<td>• With the help of a strategic consultancy firm, establish a working relationship with prestigious international centres and institutions such as Technopolis-UK, 2 Think Now-Australia, MIT and the OECD so that they may draw up reports and evaluations that endorse the recognition of Medellin as a Latin American reference in STI.</td>
</tr>
<tr>
<td></td>
<td>• Dissemination of the successful earlier establishment of R&amp;D centres by Kimberly Clark, Holcim, HP and another 14 smaller foreign firms in the Medellininnovation district with a view to encouraging other international companies to consider Medellin as an alternative to locate their STI capacities and platforms 78</td>
</tr>
<tr>
<td></td>
<td>• Support to public-private institutions such as Pro-Antioquia, and “Agenda Inspira” with seven programmes aimed at the national and international promotion of Medellin as an STI-friendly region</td>
</tr>
<tr>
<td></td>
<td>• Promoter role of Medellin’s Cooperation and Investment Agency (ACI)</td>
</tr>
<tr>
<td>Improvement of critical local factors influencing decisions concerning the</td>
<td>• Strengthening of the local innovation system: creation and empowerment of Ruta N; preparation of the city’s STI Plan 2011-2021</td>
</tr>
<tr>
<td>installation of STI-intensive investments</td>
<td>• Urban development strategy led by Medellin City Council in order to improve – among other factors - security, mobility, quality of life and digital connectivity in the city</td>
</tr>
<tr>
<td></td>
<td>• Reinforcement of English-language tuition at all levels of the educational system</td>
</tr>
<tr>
<td></td>
<td>• Support to the generation of STI-based spin-offs by research groups at universities or as local entrepreneurial projects that can be accelerated by forming alliances with global players</td>
</tr>
<tr>
<td></td>
<td>• Encouraging greater connectivity with global regions, a task included in the international cooperation agendas of both Ruta N and ACI</td>
</tr>
<tr>
<td></td>
<td>• Promotion of an innovation and entrepreneurship culture, one of the priority objectives in Ruta N’s agenda</td>
</tr>
<tr>
<td>Support to investors and decision-makers</td>
<td>• Role of Ruta N as a facilitator on behalf of Medellin City Council vis-à-vis firms interested in investing in the city.</td>
</tr>
<tr>
<td></td>
<td>• Role of Tecnnova as a knowledge brokerage agency between the different links of the STI value chain.</td>
</tr>
<tr>
<td></td>
<td>• Permanent dialogue with local multilatinas in order to retain them and reinforce their presence in the city.</td>
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</tbody>
</table>

78 Besides HP Labs, companies established in the district by December 2013 include five from the USA, four from Spain, two from Argentina, one from Switzerland, one from Chile, and one from Brazil. Most of them are ICT companies. Additionally, there is an R&D laboratory, a health sector company, and a service company (information provided by ACI).
Strategic goals | Plans, incentives and main actions
--- | ---
Specific incentives to promote the establishment of STI-intensive investments. | • Support to the creation of a supply of venture capital
• Tax benefits for new or existing companies in the ICT cluster that move to the Medellinnovation district.
• Medellinnovation district project, in the north of the city, with anchor stakeholders (Ruta N, University of Antioquia and the Sevilla, Jesus Nazareno and El Chagualo neighbourhoods). Project aimed at the establishment of high tech companies. Until December 2013, 15 foreign firms and one Colombian firm established themselves in the district, creating 700 direct jobs and expecting to reach 1,400 by 2015 (ACI, 2014).

Source: Prepared by the authors on the basis of background information provided by Ruta N (2013), Ratti et al. (2012), and ACI (2011).

As indicated in Table 1, one of the most original and at the same time most significant initiatives implemented in Medellin is the Medellinnovation district. It is a long-term project aimed at thoroughly revitalising an urban area by the promotion of knowledge and innovation.

According to the regulations of the Medellin City Council, the main tax benefit associated with establishing highly innovative technology-intensive companies in the Medellinnovation district consists in an exemption from paying as much as 75% of industrial and commercial property tax to companies whose income derives from innovative activities. This exemption can be claimed from the moment the firm generates its first income from innovative activities and extends for a period of 10 years, regardless of whether the company is Colombian or foreign. Firms belonging to Medellin’s ICT Cluster are eligible for an exemption of up to 100%. Companies that, after having been granted the exemption, hire at least two professionals with a postgraduate (master’s or doctoral) degree on a permanent contract may qualify for an additional 5% tax exemption on their income tax.\(^79\)

The Medellinnovation district is part of the strategy that the city designed in order to turn Medellin into the innovation capital of Latin America by 2021. It is an urban and economic transformation project intended to transform the north of the city into a new innovative cluster that brings together entrepreneurs, firms and institutions that play an active role in the knowledge economy and participate in high value added convergent projects. The project is still in its early development phase, its first milestones having been the Ruta N building and HP Labs.

The project is a compelling urban transformation initiative that is part of Medellin’s long-term planning instruments. In addition, it is an economic transformation project aligned with the city’s policies and strategies in terms of competitiveness and economic development. The goals of the project are the following:

1. To support the expansion of existing research activities and of educational and cultural institutions to stimulate a creative ecosystem and provide high quality training to the workforce of the future in the areas of health, wellbeing, biotechnology and green technologies.

2. To attract existing Medellin-based firms as well as global companies in order that they establish part of their R&D activities in the district to share in the benefits of the local cluster strategy.

\(^79\) The constellation of tax benefits applicable to Medellin’s STI district were approved by virtue of Article 64 of the Medellin City Council Agreement (2012).
3. To promote new business initiatives specifically aimed at the application of digital technologies to the creation of innovative products and services that may satisfy the needs of potential markets in emerging economies.

4. To place all the goals above within a highly liveable and digitised environment that provides housing and educational opportunities, encourages trade and work and is accessible to all segments of society.

In addition, the project centres on a district-based strategy, which is articulated around four components and seven principles. Both the components and the principles constitute a single and systemic proposal aimed at the constitution and implementation of the Medellinovation district project. The components of the strategy are related to economics and business, the urban landscape, mobility and digital technologies. Principles, on the other hand, are: localisation; digital commitment; inclusiveness; convergence; connectivity; diversity and global vision.

From the outset, Ruta N has based its strategy on the attraction of innovative technology-based firms to Medellin. Within the framework of its Landing strategy, seven international knowledge and services-intensive firms settled in the city during 2012. Five of them are oriented toward the production/integration of specialised software: Lex Paradigm, Sproudloud, Tairo, Staunch Robots, Velocity Partners; one of them devotes itself to innovation management for corporate matters (Instiglio) and the last one is dedicated to talent and human resources management (MSH). Six of these companies are from the United States and the seventh from Spain. It is interesting to note that the activities of Instiglio in Medellin have gradually veered toward the implementation of social innovation projects in countries like India, Chile, Mexico and Brazil. This example suggests that social innovation – one of the cross-cutting themes that has run through this Review – can also become an important factor in attracting foreign direct investment.

Most of these firms are medium-sized and have been established recently in their countries of origin. This points to the importance of addressing the investment attraction strategy not only toward large multinationals that are already consolidated in their respective sectors but also to smaller foreign STI-intensive companies and start-ups. These firms are very likely to soon behave as highly dynamic companies, known as gazelles for their capacity to attain high rates of growth and job creation over short periods of time.

Undoubtedly, the two greatest successes achieved by Medellin in its strategy to attract global technology-intensive companies have been, in the first place, the selection by Hewlett-Packard of Medellin (over other alternatives such as Bogota, Panama City and Santiago de Chile) for the establishment of its HP Labs division in 2008 (there are only seven HP Labs worldwide). The other is the investment made by Kimberly Clark to create a global innovation centre in Medellin.

HP Labs currently employs nearly 200 people in Medellin, most of them in highly-skilled jobs, and they expect to reach the 1,000 jobs mark over the next five years. Ninety percent of their current staff were sourced locally. HP Labs does research work and collaborates with the local industry in the development of applications for energy, logistics and city management, such as systems for replacing cables and lamp posts, among others. Developing systems jointly with local firms means that agreements are constantly made regarding development schedules and joint intellectual property terms.

Kimberly Clark’s investment, which totalled USD 20 million, involved the construction of a 10,800 sqm building in the Manantiales Technology Park. The multinational had only constructed two similar facilities before: one in the USA and the other in Korea. Institutions such as ProExport and Medellin’s...
Cooperation and Investment Agency (ACI) played a key role in the conversations with Kimberly Clark that finally led to their establishment in the city. Apart from the district’s efficient logistics infrastructure and easy access to critical resources, there was one factor that ultimately tipped the scales: the city and the region’s deep commitment with technology. For Kimberly we carried out an analysis of the whole regional innovation system, which comprises universities, graduates, excellence groups, different competences, laboratories, the various facilities, which universities have hospitals, what specialities are offered, etc. It seems that what they saw convinced them. Naturally, other factors also played a role such as the quality of life in the city, the transport system, etc., but the make or break factor was the unswerving commitment of the public authorities with innovation, pointed out an ACI representative.  

Other notable examples of less STI-intensive investments by external firms in Medellin are those by Algar Tech (Brazil), devoted to designing ICT solutions for business processes and customer management, established in 2013; Emergia (Spain), oriented toward outsourcing business processes, whose contact centre opened in 2011 and Holcim (Switzerland), a multinational cement manufacturer which established its BPO platform in Medellin in 2012 to support the firm’s transactions in Latin America.

SWOT Analysis

As noted in previous chapters, the fact that multinational firms such as HP and Kimberly Clark have considered – and selected- Medellin as a destination to establish R&D platforms is proof that the city is recognised for its relevant attributes for that kind of decisions by global companies. The city has succeeded in outgrowing the stigma of criminality and drug trafficking and has come to be known as Colombia’s capital for innovation and dynamic entrepreneurship.

Medellin provides a well-established local business base; a strategic framework of leading public and private institutions that have a shared view of the STI-intensive sectors that should be considered a priority for productive development; a base of universities and R&D centres boasting technology transfer platforms; and a wide range of financial and non-financial services available to companies. Any company wishing to transfer their STI capacities to Medellin will find a much more vigorous business environment than in any average medium-sized Latin American city.

However, Medellin-based companies – both local and external – that have the capacity to innovate recognise that the availability of advanced human capital, sophisticated technological specialisation, and English language skills is limited. As a result, the need to strengthen local strategies aimed at attracting and retaining talent and to develop technical and vocational training programmes consistent with the skills required by investing companies cannot be overstated.

Another aspect that may undermine the impact of the initiatives geared to promoting innovation considered and which negatively affects the local business environment is the excessive amount of red tape and other regulatory impediments that often stand in the way of the smooth development of business. Even if part of these restrictions are imposed by the national regulatory framework, there is room to implement initiatives at local level – such as one-stop-shop systems and online service platforms - that may result in facilitating administrative procedures and decreasing the bureaucratic burden for STI-driven entrepreneurs and investors. According to the Doing Business 2014 report, Medellin is ranked 11th out of 23 cities in Colombia in terms of ease of doing business, behind cities like Manizales, Ibague and Pereira. This shows that there is still significant room for improvement in this respect.

81 Press release in Summa magazine, 10 August 2012.
82 BPO: Business Process Outsourcing
One more issue that must be examined is the current level of integration and coordination between the functions and agendas of Ruta N and ACI, especially as regards their international projection and their relationship with foreign entities, two indispensable requirements for attracting STI-intensive investments. This would allow maximising synergies and avoiding duplication of efforts and connection channels with external stakeholders.

Medellin offers no relative superlative advantages in terms of location, physical connectivity or proximity and accessibility to ports and airports as compared with foreign cities like San Jose or Panama City, or other Colombian cities like the capital Bogota or Barranquilla. This limitation mandates that additional improvements should be made to the local innovation system, the business environment, the level of digital connectivity and quality of life in order to attract talent and investments intensive in advanced human capital. At the same time, the international reputation achieved by the city on account of its innovative ecosystem and high-quality habitat is an asset that must be preserved and developed through an active international connection and collaboration strategy, in which both Ruta N and ACI must play relevant roles working in close coordination with each other.

Table 12. SWOT Analysis

<table>
<thead>
<tr>
<th>Strengths</th>
<th>Opportunities</th>
</tr>
</thead>
<tbody>
<tr>
<td>Medellinnovation district flagship project</td>
<td>Progress and recognition achieved by Medellin as an attractive destination for global companies</td>
</tr>
<tr>
<td>Existence of a range of differentiated incentives (Landing programme, tax benefits) for STI-intensive and dynamic companies wishing to establish themselves in Medellin</td>
<td>Recent articulation of a local supply of smart capital to finance young companies, which reinforces the possibility that external STI-intensive start-ups may want to set up shop in Medellin</td>
</tr>
<tr>
<td>Portfolio of relevant case-studies on the installation of multinational companies in the city</td>
<td>Growing reputation of Medellin as a regional leader in the field of social innovation and urban development contributes to its ability to attract talent and investments in STI</td>
</tr>
<tr>
<td>Existence of a local STI-ecosystem, perceived as a relative strength due to the availability of a local supply of STI capabilities; a sophisticated STI demand by multilatinas; and competent knowledge brokerage agencies like Tecnnova</td>
<td>Colombia’s potential accession to the OECD opens new channels of international cooperation and collaboration, which may provide the city with greater visibility and a and international connectivity</td>
</tr>
<tr>
<td>ACI as a promoter and investor service provider</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Weaknesses</th>
<th>Threats</th>
</tr>
</thead>
<tbody>
<tr>
<td>Performance of the city in terms of ease of doing business (DB Report Colombia 2014: ranked 11th out of 23 cities in the country)</td>
<td>Emergence of competing cities in Colombia and neighbouring countries as preferred destinations for R&amp;D-related funding, given their strengths in the field of logistics and their decision to strengthen some of their other attributes (Panama City, San Jose, Barranquilla, Bogota, among others)</td>
</tr>
<tr>
<td>Limitations and mismatches in the local supply of advanced human capital and a skilled workforce</td>
<td>Urban growth may in the future become a source of diseconomies of scale and reduced quality of life</td>
</tr>
<tr>
<td>Low international profile of ACI (in contrast with Ruta N) in terms of attracting foreign STI-intensive investments</td>
<td></td>
</tr>
</tbody>
</table>

Source: Prepared by the authors.

Recommendations

The remarkable progress achieved by Medellin in recent years in terms of its visibility and international reputation as an attractive destination for STI-based investments and enterprises should be sustained and intensified in the future by means of a strategy aimed basically at increasing the flow of innovative businesses that choose to hang out their shingle in the city. The following are recommendations that could be included in the above mentioned strategy:
• Strengthen and provide international guidance to the Medellinnovation district project;
• Elaborate further on Medellin’s marketing strategy and international status as a destination for STI-intensive investment;
• Strengthen the international profile of Medellin’s Cooperation and Investment Agency, promoting closer links with Ruta N to attract STI-intensive investments;
• Deploy a plan geared to attracting, managing and retaining business and entrepreneurial talent;
• Attract international corporate excellence in STI; and
• Reinforce Medellin’s leadership among Latin American cities in the field of urban development and quality of life.

Strengthen and provide international guidance to the Medellinnovation district project

Medellinnovation was projected as an STI-based district in the north of the city. The idea behind this project was to promote innovation and knowledge as sources of local development. According to the initial plan, the district was intended to provide a space within the traditional metropolitan fabric where new industries could converge to form a creative constellation oriented toward new products, ways of doing business and lifestyles. (Vargas et al., 2013, page. 34). The project is on the cutting-edge of urban interventions in Latin America and combines a desire to promote urban rehabilitation with an urge to revitalise Medellin’s economy through a strong emphasis on innovation, dynamic entrepreneurship and the knowledge economy.

For the reasons above, it would be advisable to manage and promote Medellinnovation by drawing on the experience of the European regions that have successfully implemented innovative technology parks or districts. A specific recommendation in this regard would be to establish an advisory board consisting of persons that have had direct responsibility for the implementation of initiatives such as District 22@Barcelona or the Zamudio Technology Park in Bilbao. A significant reference in Latin America is the Zonamerica complex in Montevideo. These initiatives are summarised in Box 25.
Box 25. Outstanding experiences of developing urban innovation districts

Barcelona (Catalonia, Spain): District 22@Barcelona is a project launched in 1998 with the opening of Diagonal Avenue, in the old neighbourhood of Poblenou, to the sea. The district, which extends over an area of 200 hectares, was in a state of absolute dereliction as a result of the obsolescence of the urban industrial fabric that had developed in the second half of the 19th century and the first half of the 20th. The project was based on the simultaneous implementation of four transformation vectors: talent, businesses, innovation and town planning. Thus 22@Barcelona integrates the different stakeholders that are part of the innovation system: high tech companies, universities and continuous training centres, and research and technology transfer centres, along with several promotion agencies that facilitate interaction and communication between firms, educational institutions and research centres. Coexistence of these innovative and dynamic companies with the routine activities of the neighbourhood – shops, small workshops, basic services – gives rise to a rich and productive environment that promotes knowledge and innovation-based synergies (http://www.22barcelona.com/)

Bilbao (Basque Country, Spain): The Zamudio Technology Park, established during the second half of the 1980s as a bulwark of the Basque Country’s productive reconversion strategy, is at present home to around 220 firms, which together turn over EUR 2.5 billion a year and provide 7,500 highly-qualified jobs. On average, companies in Zamudio devote 10% of their turnover to R&D activities. The value proposition of this real-estate and urban regeneration project could be summarised by saying that companies that establish themselves in Zamudio pay for the hardware (infrastructure) and, in return, have access to a rich software of business services and agglomeration economies thanks to being in the vicinity of cutting-edge companies and R&D centres. Although Zamudio had promoted a multisectoral approach since its inception, in the last few years a growing trend has been observed toward the establishment of firms specialising in new technologies. (http://www.parque-tecnologico.es/)

Montevideo (Uruguay): The Zonamerica free trade area is currently home to over 20 international advanced high tech service companies that provide 9,500 direct jobs, most of them for medium to highly qualified workers. Over an area of 90 hectares, which includes office buildings and warehouses, Zonamerica develops real-estate services, human resources support, infrastructures and IT flexibility and scalability services in a campus-like environment that stimulates growth and the creation of synergies between the different business platforms on site. (http://web.zonamerica.com/).

Source: Prepared by the authors on the basis of personal visits and information from the projects’ respective websites.

Elaborate further on Medellin’s marketing strategy and international status as a destination for STI-intensive investments

The international race to attract high technology investments is fierce. At least 15 Latin American cities can compete with Medellin in attracting new STI-based investments (Universidad del Rosario, 2013).

Not only do all relevant stakeholders in Medellin share a vocation to turn the city into a magnet for STI-based enterprises but also the city has all the attributes to make it happen. This means that all efforts aimed at international promotion of the city can be based on real attributes grounded in specific examples of players that have already chosen to establish STI-based businesses in the city. In other words, future strategies to advertise the merits of the city will be based not only on visions of the future but also on successes and achievements already attained in the present.

The public players who are in charge of promoting the internationalisation of the city (Chamber of Commerce, ProAntioquia, Ruta N, among others) must consider the need to embark on a new phase that recognises and actively disseminates the successes and achievements already attained, defining key markets (for example the West and East coasts of the United States, Asia-Pacific, Spain, Brazil and the Southern Cone, among others) according to the potential commercial alliances, partnerships and direct
investment opportunities that they offer. It would also be very useful to engage specialised consultants who
can detect potential STI-intensive investment opportunities, setting them ambitious performance goals
including the successful installation in Medellin of high tech and/or knowledge-intensive firms and
institutions. The search for anchor companies to spearhead the establishment of STI-driven companies in
the Medellin innovation district could also be included within the remit of such consultants.

In this connection, it would also be important to resort to highly specialised negotiators in each of the
target markets, who can collaborate with the aforementioned consultants and whose remuneration would
combine a fixed payment plus a variable success fee depending on the nature and magnitude of the
business and investments actually generated.

A good example of successful international promotion of a sub-national region, supported by a
network of partners in the main target markets, is provided by the German Länder of North Rhine-
Westphalia (NRW) which created a specialised agency called NRW–Invest to promote the benefits of
investing in NRW and provide investors with support and strategic guidance. NRW Invest has established
a network of partnerships in such countries as the USA, Japan, Russia, China, India and Turkey, among
others (http://www.nrwinvest.com/).

In this context, the role of ACI is essential for Medellin given its international profile and its close
relationship with Ruta N. The recommendation below addresses this issue.

Strengthen the international profile of Medellin’s Cooperation and Investment Agency, promoting
closer links with Ruta N to attract STI-intensive investments

The Cooperation and Investment Agency of Medellin and its Metropolitan Area (ACI) was created in
2002 by the City Council as Medellin’s international cooperation agency. It took its current name
in 2007, when the task of attracting foreign investment to the city was added to its functions.

ACI plays a key role in the strategy to internationalise the local economy. As regards connectivity
with global innovative regions, Medellin possesses all the characteristics and attributes to behave as a
hinge region with respect to the rest of Colombia and Latin America, which places it in an encouraging
situation to become a magnet for STI-intensive investments. 84 A strategy in this respect requires close
cooperation between Ruta N and ACI, whose capabilities and functions are fully complementary, in order
to, first of all, coordinate their respective work and international cooperation agendas; secondly, better
connect their respective websites (especially their English version); and thirdly, jointly design a strategy
aimed at promoting and attracting investments in STI focusing on other innovative regions.

An interesting example of a region that has established international networks with other innovative
partners is provided by Navarre in Spain.

84 The term hinge region was taken from Benneworth and Dassen (2011)
Box 26. The case of Navarre and the accelerated construction of international networks with innovative regions

The region of Navarre in Spain boasts a high development level as compared with other European regions, with a per capita income similar to that of Emilia-Romagna in Italy. At the same time, its general performance in the field of STI is favourable, with R&D expenditure at 1.9% of the region’s GDP, a figure significantly higher than the Spanish average. Nonetheless, the relatively poor (local, national and international) connectivity of Navarrese companies, as reflected in the Regional Technology Plans 2002-04 and 2005-07, was identified as a factor that undermined Navarre’s innovative performance.

This is the reason why the Regional Innovation Strategy laid great emphasis on establishing and strengthening innovation-enabling networks. The Strategy distinguishes between four types of networks: local networks; networks made up of companies and business innovation support services; networks of ‘peer’ regions from all over the world; and global innovation networks.

Although the strategy was launched only recently, it has yielded some promising early results in terms of the active participation of universities, companies and local R&D centres in European expert networks, specialised technological platforms and global STI networks.

The case of Navarre illustrates the fact that regional STI strategies must be aimed at strengthening the local innovation ecosystem, stimulating at the same time its connectivity by means of the active participation of local players in networks of peer regions from all over the world and in global innovation networks. This progress toward greater international connectivity is a necessary condition to attract a growing number of STI-intensive investments. Success of the Plan is contingent on a high degree of coordination between the relevant local public agencies in their promotion and external cooperation initiatives.

Deploy a plan geared to attracting, managing and retaining business and entrepreneurial talent

Medellin has become an alluring city for enterprising talent from other regions in Colombia and from neighbouring countries as a result of having created an ecosystem that supports innovative entrepreneurship, based on the promotion of an entrepreneurial and innovation-prone culture; a wide-range of support mechanisms deployed by public agencies like Innpulsa, Ruta N and Medellin City Council; the recent establishment of venture capital funds in the city aimed at launching start-ups; and the existence of platforms such as Tecnova specialising in supporting technology-intensive businesses.

In the next few years, it will be crucial for Medellin to attract advanced human capital, i.e. highly qualified entrepreneurs, professionals and specialised technicians who can be recruited by the firms investing in the city or, alternatively, join their value chain as suppliers. This raises the possibility that Ruta N, together with ACI, may implement an international programme for recruiting and managing human resources, in close cooperation with the corporate policies established by the multinational companies and multilatinas already based in the city.

As pointed out in Chapter 2, it is essential to tackle the rather poor English-language skills of the workforce with pragmatic measures aimed at developing those skills and by administering internationally recognised exams (TOEIC or TOEFL for example) that attest that the candidates’ command of English is good enough for their job. At the same time, English-language tuition in primary and secondary school must be improved and the development of schools where English is the first language would also be desirable, particularly for the children of foreign professionals, technicians and entrepreneurs.

Attract international corporate excellence in STI

The increasing presence in Medellin of a critical mass of multinational corporations and multilatinas with STI capabilities and networks of their own opens the possibility to aspire to more ambitious ventures,
co-funding the establishment of incremental capabilities as well as medium-term R&D development plans. The purpose should be to establish a smart specialisation strategy for the city (referred to in chapters 1 and 4) that focuses on a series of priority themes and business areas that hold promise for the future such as the development of specialised software geared to smart cities, energy eco-efficiency and e-health.

A relevant example of this initiative is the International R&D Centres of Excellence Programme developed in Chile, which focused on the capital Santiago.

**Box 27. International R&D Centres of Excellence Programme, Chile**

The “Attraction of International R&D Centres of Excellence” (CEI) programme is aimed at promoting and implementing the establishment of world-class STI-intensive firms and organisations in Chile. The programme was launched in 2011 by CORFO, the Chilean Economic Development Agency. The purpose of the programme is to stimulate international firms and corporations to develop technology-intensive products, services and processes from Chile.

The total cost of the R&D centres of excellence stands at approximately USD 77.6 million, of which CORFO would in principle contribute around USD 25.6 million (33%) and the companies USD 52 million (67%) over a 4-year period. During 2013, four centres of excellence were awarded to international companies and corporations: GDZ Suez Laborlec, Telefonica, Emerson and Pfizer. This Chilean programme provides a very good example of how public authorities can effectively attract international investment in STI promoting and stimulating the establishment of foreign capabilities and resources in the country that forge partnerships, make use of local suppliers and energise the productive sectors they operate in. For the programme to be a success, the strategy and operational plans of the centres should pledge a firm commitment to co-develop R&D projects with local companies, universities and local R&D centres, and to hire and train local advanced human capital. If this requirement was not imposed, a non-refundable grant by a public agency like CORFO would make no sense.

A programme like this one could have a significant impact on Medellin. It could be added to the arsenal of initiatives that make up the current strategy to attract firms and institutions, and the centres of excellence would act as flagships in the different geographical areas where they are established, benefiting from a host of incentives and prerogatives promoted and implemented by Ruta N.

Given the cost of such a programme, it may be a good idea to implement it at national level and consider a potential contribution of funds coming from the STI fund, provided that eligibility of a project requires an irrefutable demonstration of the establishment of alliances with universities and/or R&D centres from the region of Antioquia, and a clear specification of the expected benefits and externalities.

For further information, see full description of this programme in Annex A.

**Reinforce Medellin’s leadership among Latin American cities in the field of urban development and quality of life**

On a recent ranking of the most attractive Latin American cities for investment, Medellin was ranked as the 13th most attractive city for investments out of a total of 48 metropolises in Latin America and the Caribbean (Universidad del Rosario e IdN, 2013). This ranking is based on five groups of indicators: (i) size of the market and economic performance; (ii) purchasing power and urban comfort; (iii) recognition and presence of global players; (iv) financial leverage capacity; and (v) higher education standards.

The second and fifth group of indicators, i.e. those related, respectively, to urban comfort and human capital can be considered to be intimately linked to possibilities for human development and the standard of living offered by the city. It must be recognised that the rating obtained by Medellin on these criteria is lower than its average score. Indeed, in terms of human capital it was ranked in 15th position whilst on human comfort is only came in 34th out of all the cities evaluated.
Table 13. Relative position of Medellin according to relevant criteria

<table>
<thead>
<tr>
<th>Criteria</th>
<th>Medellin’s rating</th>
<th>Relative position</th>
<th>Top-ranked cities</th>
</tr>
</thead>
<tbody>
<tr>
<td>Financial capacity</td>
<td>High</td>
<td>4</td>
<td>Santiago, Sao Paulo, Panama City</td>
</tr>
<tr>
<td>International reputation</td>
<td>51,2</td>
<td>12</td>
<td>Sao Paulo</td>
</tr>
<tr>
<td>Human capital</td>
<td>36,6</td>
<td>15</td>
<td>Sao Paulo, Mexico City</td>
</tr>
<tr>
<td>Urban comfort</td>
<td>66,6</td>
<td>34</td>
<td>San Juan, Montevideo, Santiago</td>
</tr>
</tbody>
</table>


Medellin’s international standing must be balanced by “inward-looking” action aimed at improving and continuously monitoring aspects of the local business and innovation environment where the greatest weaknesses have been detected according to interviews with STI-driven investors and entrepreneurs. This local action must focus on the training and availability of qualified and English-speaking human resources, extensively discussed in Chapter 2 of this Review, and on the maintenance of investments and social innovations to promote the improvement of the city’s quality of life, among other priorities.

Dialogue between investors and local authorities may be enhanced if ACI and Ruta N established a forum which periodically brings together entities representing the local business sector and investors to systematically identify areas of improvement and discuss potential solutions.

The city is in the midst of an expansion phase. Such an expansion often results in the unexpected intensification of problems such as traffic congestion, long travel times, crime, noise and pollution. In this context, the availability of infrastructures and of an efficient transport network becomes an indispensable requirement in order to respond to the challenges that Medellin must face in order to achieve the living conditions and high quality of life it aspires to. The city will therefore have to combine significant investment plans with smart management systems, including concession agreements, new infrastructures and good public services. Medellin has already earned itself a reputation for the development of innovative public assets and services such as an efficient urban transport system and improved heritage and cultural infrastructures.

The increase in the inhabitants’ living standards obtained thus far, a highly commended achievement by both entrepreneurs and investors, will be a particularly important factor going forward. Nevertheless, the inequality between the richer and poorer inhabitants of the city, and between Medellinenses and the poorer populations of the rest of Antioquia, in terms of access to opportunities, may pose a threat to the sustainability of the city’s development if the long-term strategies aimed at narrowing those gaps and alleviating poverty are not duly strengthened and renewed.

The above, nonetheless, provides the opportunity of developing initiatives in the field of social innovation. Medellin is recognised as a pioneering city in this realm, thanks to the vision of its local authorities, and the engagement and contribution of Empresas Públicas de Medellín. This requires designing an ambitious urban development strategy, as was widely recognised during the seventh session of the World Urban Forum held in Medellin in April 2014, which can project the city’s leadership in the field throughout Latin America.
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ANNEX A

LEARNING MODELS

Learning Model 1: Dual vocational training programme, Germany

The dual vocational education and training (VET) system in Germany is considered a major factor in the country's economic success and inventiveness over the past six decades. Its holistic approach, high quality and widespread reputation have made the dual system an export success too.

Several countries around the world have modelled their own VET systems on the German experience (Austria, Bosnia-Herzegovina, China, Croatia, Denmark, France, Macedonia, Montenegro, the Netherlands, Serbia, Slovenia, Switzerland, and other countries in Asia, among others). The German dual vocational training system has a tradition that dates back to the twelfth century. Its holistic approach involves both in-house training and education at vocational schools.

Contents and training methods are largely determined jointly by industry and training colleges to reflect current vocational practice and ensure a successful blend of theory and practice. Each year, about 60% of German school leavers choose to enter the dual system, ensuring that in Germany young people are integrated into the workforce with a degree of success almost unparalleled in Europe.

Programme description

In Germany, the dual system is at the core of vocational education and training in Germany. It is based on the Vocational Training Act of 1969 (amended in 2005) and remains the main pathway for the young generation into the workplace. Every young person who has completed full-time compulsory education can access dual vocational training. One key feature of this system is that it comprises two learning venues: the company and the vocational school.

The term dual also denotes the specific situation where the federal government is responsible for in-company vocational training, and the federal states (Länder) are responsible for vocational training in schools.

Companies conclude training contracts with applicants under private law and provide training in accordance with the provisions defined in vocational training regulations, which are binding and guarantee a national standard. Compliance with these standards is monitored by competent bodies such as the chambers (of industry and commerce, crafts, agriculture, doctors, lawyers) and also by other bodies in the public service or under the purview of the churches.

The dual system provides broad vocational training for 344 recognised occupations (2012). The average duration of programmes in the dual system is three years, with some programmes lasting 2 years and other 3.5 years.

Upon completing their training in the dual system, the majority of participants take up employment as skilled workers. At a later stage, many of them take advantage of the opportunities available to pursue continuing vocational training. Outside the dual system there are also VET programmes in full-time
vocational schools (for approximately 15% of the age cohort). These programmes last between 1 and 3 years, depending on each individual's particular vocational orientation and specific career goal.

**Relevance to Medellin**

Two of the most obvious features that make the German VET model relevant to Medellin are the following:

- A dual system may help Medellin address the inverted pyramid predicament (i.e. the percentage of graduates from higher education exceeds that of vocational training graduates), increasing the supply of labour with technical skills so that it matches the actual demand of the local labour market. Additionally, the commitment of the business sector with the system could help improve the public perception of technical training; and

- Make more qualified and more innovation-prone human capital available to local MSMEs, which account for over 97% of all businesses in the region. At present, most of these firms operate in traditional and mature sectors, which make it necessary for a significant part of them to embrace innovation processes to improve their productivity. The dual VET scheme would help energise and enhance the knowledge base of these companies, a key prerequisite for change.

**Programme results**

In 2011, according to the German vocational education and training statistics, there were 1,460,658 young people in dual vocational training. The number of enterprises providing training that year totalled 455,100.

**Keys to success**

The dual vocational training is at the core of the German VET system. Its purpose is three-fold:

1. Economic productivity;
2. Social integration; and
3. Individual development.

The scheme provides tangible benefits for each one of the actors involved: the main benefit for trainees is to receive relevant training that meets the requirements of the labour market, enhancing their employability, improving their social skills and developing their personality through direct theoretical and practical experience. For companies, it works as a method to select their workers: hiring a trainee after completion of their training is advantageous for the firm as the trainee is already known to them and at the same time is familiar with the operations and working philosophy of the company. Finally, the government also benefits from the dual system as it eases the burden on the public budget thanks to the participation of the business sector in ensuring that the workforce's skills are always up to date.

**Barriers and corrective measures**

The number of newly concluded training contracts decreased in 2012 in relation to the previous year by approximately 3.2%. The supply of training vacancies stood at about 585,000, which entails a 2.4% decrease with respect to the previous year. The decrease in the absolute number of contracts awarded is due to the negative demographic trend; it is thus possible to assert that training opportunities for young people deteriorated only slightly compared to the previous year.
A significant number of young people do not have access to the dual vocational education and training system. At the same time, many companies are finding it increasingly difficult to fill their vacancies for trainees. An estimated 37.4% (2012) of the firms that offer training vacancies were partially or completely unable to fill them.

The figures show that the interest of school leavers in dual vocational education and training is decreasing. The reason for this is an increase in the numbers of young people entitled to access higher education, which has resulted in a change in the composition of the student population. As a result of the lower numbers of students, employment opportunities for young people interested in dual education and training have improved.

The rate of firms participating in the VET programme shrank by 0.8% to 21.7%, the lowest level since 1999. This decline was largely due to the creation and growth of smaller companies.

**Considerations for potential adoption by Medellin**

It is essential for Medellin to carry out an in-depth analysis of the VET experience in Germany (and possibly in other countries that have adopted the dual training model) and the factors contributing to its success. This should be done in collaboration with SENA (Colombian National Vocational Training Agency), which has already adopted and is implementing a dual training system.

In parallel with the specific experience of SENA, a diagnosis of the situation in Medellin and Antioquia as a whole would allow identification of the elements required to optimise the impact of the dual VET system in the local context, particularly with a view to activating and promoting innovative practices in Antioquia’s MSMEs system through the generation of skilled and dynamic human capital.

This comparative analysis should contribute to finding ways to revise and update and, at the same time encourage, SENA’s dual VET system, as well as ongoing in-company training, as key elements of the local innovation strategy.

Two limiting factors exist in Medellin that are not present in the German context. One of them has to do with the size of companies. German firms involved in dual training are often large or very large companies, and have the ability and strength to play an active part in this kind of training even by investing their own equity. As this capability is beyond the reach of most of Antioquia’s companies, a few changes will have to be introduced into the VET system to ensure its successful implementation in Medellin.

In Germany, a robust governance system has developed over the decades between the federal government (responsible for in-company vocational training) and the Länder (responsible for vocational schools). In Medellin is will be necessary to define the role of the different institutional actors to ensure a joint long-term vision that goes hand in hand with a capacity to act in a sensible way that responds to the specific local and regional needs.

**Further reading**


Learning Model 2: Research Centres of Excellence Programme, Singapore

Programme description

Singapore has around 5.3 million inhabitants; slightly less than the population of Antioquia (6.2 million). Singapore’s rapid economic growth in recent decades is closely related, firstly, to its success in attracting multinational companies and, secondly, to the constant efforts to develop national STI capabilities. In the late 1980s, R&D expenditure as a percentage of GDP was below 0.9%, but two decades later, around 2010, the ratio exceeded 2%.

Singapore’s national innovation system is the most advanced in Southeast Asia and continues to improve, taking advantage of the opportunities provided by its proximity to the two major emerging markets of China and India. Initially, efforts to build the national innovation system focused on offering incentives aimed at attracting increasingly higher value-added activities (advanced manufacturing, innovation centres, regional offices, etc.) of large foreign multinational companies in high technology sectors. But over the last decade there has been a shift towards a more balanced approach, with greater emphasis on endogenous development of scientific and technological capabilities (OECD, 2013).

An example of this shift in focus was the creation in 2006 of the National Research Foundation (NRF), with a mandate to develop new R&D policies and provide public funding for strategic initiatives, including in particular the development of research centres of excellence and the attraction of well known foreign researchers.  

Indeed, since 2007 one of the main missions of the NRF has been the development of research centres of excellence, especially focused on three strategic areas for the country: 1) biomedicine; 2) environmental and water technologies; and 3) ICT and digital and interactive content. For this purpose, the NRF launched two complementary centres of excellence programmes: the RCE programme focused on building high-standard research groups in national universities, and the CREATE programme aimed at attracting foreign universities of international renown to create new R&D centres in Singapore. We briefly describe each of them:

Research Centres of Excellence (RCE)

Through a competitive call, launched between 2007 and 2010, five centres of excellence located in national universities were selected to develop cutting-edge research related to the strategic objectives of Singapore. The general objectives of the programme are:

- To attract, retain and support internationally renowned researchers.
- To improve graduate education in universities and train qualified researchers.
- To generate new knowledge in the specific area of inquiry of each centre. This in turn must be aligned with the strategic priorities of Singapore.

85 Website at: http://www.nrf.gov.sg
The selection process was structured in two phases: in the first phase research groups submitted a preliminary proposal to the NRF Secretariat. After that, a number of centres were shortlisted, which were subsequently asked to submit a detailed final proposal. An Academic Research Council, consisting of renowned international scientists, was created to evaluate the proposals.

Centres must be located in a national university and employ between 15 and 25 principal investigators, whose contracts must link them both to the centre and the university concerned. In addition to the principal investigators, institutions have the budget to build a team of young researchers, both doctoral and postdoctoral, as well as technical support personnel. The research centre has a significant degree of autonomy in developing its research programme, which must be approved by its Governing Board. Each centre is led by a Director who must be a scientist of international renown, who is assisted by a Scientific Advisory Board. Despite this autonomy, the activities of each centre of excellence are evaluated every three years by a panel of independent international evaluators (International Review Panel) who have to determine whether the centre complies with a series of criteria and, on the basis of their findings, decide on the continuity of public funding.

Campus for Research Excellence and Technological Enterprise (CREATE)

Within the framework of this programme, a new state-of-the-art building was erected to house a campus where foreign universities could locate their new R&D centres. The NRF launched an international campaign to recruit these centres, providing public funding to the projects deemed most relevant to Singapore's research agenda, with the requirement that they must employ local researchers and interact with national universities and national research centres as well as research groups in their countries of origin. The goal was to surround CREATE with a multicultural and multidisciplinary research community whose members interacted closely with each other, with other research groups in the country and with international research networks.

The CREATE campus currently houses more than 1,200 researchers and is located in an area of 67,000 square meters in the vicinity of the National University of Singapore (NUS), the country's largest university, with the aim of facilitating interactions between the new R&D centres of foreign universities and existing local R&D groups, and fostering mutual access to facilities and scientific equipment. Besides the new R&D centres of foreign universities, the campus also houses a start-up incubator support programme. The CREATE building was designed with the highest standards of environmental sustainability, using new energy efficient technologies such as photovoltaic panels, which give scientists an opportunity to test the most advanced solar technologies, in line with the tenets of innovative public procurement presented in Chapter 5.

Relevance to Medellin

As noted in Chapter 3, it would be advisable to seek ways to strengthen the leading research groups in Medellin, assigning funds in a more selective way and promoting synergies between existing groups. Concentration of resources devoted to R&D would help achieve a critical mass of centres of excellence that may contribute to a more effective generation and dissemination of knowledge. In this regard, Medellin could contemplate the implementation of a centre of excellence programme that also seeks to encourage the internationalisation of the local innovation system and attract first-rate institutions and talent. For all these reasons the Singaporean programmes are of the greatest relevance.

Programme results

The CREATE and RCE programmes managed to create a total of 15 research centres that have the makings to become international benchmarks and contribute to scientific progress in the priority areas for
the country: biomedicine; water and environmental technologies; ICT and digital and interactive contents. These centres have already started intensive research and have produced hundreds of scientific papers and patents. What is more, they have managed to attract major league foreign researchers. However, it is still early to assess more accurately the programmes’ economic and social impact, since many of these centres were created less than five years ago.

At first, the RCE programme selected and launched five centres of excellence (between 2007 and 2010) (Table 17). The fact that three of these centres were linked to the National University of Singapore (NUS) while the other two were integrated into the Nanyang Technological University (NTU) demonstrates a willingness to prioritise scientific excellence rather than favour a more uniform distribution across the country’s universities. The director of each of the 5 selected centres of excellence is an internationally renowned researcher recruited from a foreign university (USA, Europe and Australia), so the programme also made a direct contribution to the attraction of international talent.

Second, the CREATE programme had attracted until 2013, 10 foreign universities from six different countries (USA, Israel, China, UK, Germany and Switzerland), including well-known universities like MIT, the University of California at Berkeley, and Cambridge University. These 10 universities created new R&D centres in strategic areas of inquiry for Singapore (Table 18), hired domestic and foreign researchers, and entered into collaboration with universities and local businesses on new research projects.

In 2013, CREATE won the Laboratory of the Year award, conferred by the American R&D Magazine, for its effort to build an architecturally attractive building adopting the highest standards of energy efficiency.

However, recent efforts by the Singapore government to attract foreign institutions have not been limited to the attraction of universities in the framework of the CREATE programme. They have also managed to prevail with multilateral institutions to install research facilities in the country. Such centres include the “UNDP Global Centre for Innovation and Research in Public Service,” created in 2012 by the United Nations Programme for Development, and the “Singapore Urban Hub-and Infrastructure Centre of Excellence (IFCOE),” created by the World Bank in 2011, among others. Also worth noting are the efforts made by Singapore to attract highly skilled foreign workers in order to meet the demand of multinational companies. These efforts, promoted by government agencies like Contact Singapore, the Economic and Development Board and the Ministry of Manpower, have resulted in legislative changes concerning work and residence permits and in the development of information and support services for skilled immigrants.

**Key success factors**

The programme enjoyed the unswerving support of the government of the country and was diligently managed by the newly created National Research Foundation (NRF). The programme's success in attracting foreign universities and scientists of international prestige to direct the new centres of excellence resulted from the attractiveness of Singapore and its international reputation, which is linked to its impressive track record regarding its ability to attract large multinational companies and develop a more flexible, dynamic and internationalised domestic innovation system that that of most of the world's developed countries. Another factor contributing to the attractiveness of Singapore is its geographical situation, particularly its proximity to China and India, the largest and most dynamic emerging markets.

**Considerations for potential adoption by Medellin**

The case of Singapore is a good example of how programmes focusing on research centres of excellence can be combined and reinforced by attracting foreign researchers and institutions. However, attracting foreign universities and researchers to Medellin could create tensions as local research centres
and their researchers might fear that the available funding will now be directed to foreign institutions rather than to the local scientific ecosystem.

There is a certain parallelism between Ruta N’s building in the Medellín innovation district and the CREATE campus because both are modern and were built in the vicinity of the main universities of the region, with the aim of attracting businesses and innovative institutions. Although Ruta N is currently focusing on attracting businesses, it has also taken steps to attract foreign universities (such as Purdue University, as described in Chapter 3). The Singapore model can serve as an example, alongside the Chilean International R&D Centres of Excellence programme, of how to devise more ambitious programmes to attract foreign universities to help strengthen the local innovation system.

In short, the case of Singapore is interesting for Medellin, but there are many possible design options for a centre of excellence programme, depending on the characteristics of the country/region, its institutional framework, and the strategic objectives that need to be prioritised (Guimón, 2013). Therefore, rather than trying to transfer the experience of Singapore directly to Medellin, the challenge would lie in finding the solution that is best-suited to the local conditions, for which further internal debate on the potential design of a research centre of excellence programme is required. Although no figures are available on the budget for these programmes in Singapore, they are clearly very ambitious programmes, whose budget can hardly be matched by Medellin in the short-term.

Further reading


https://www.innovationpolicyplatform.org/document/building-research-centres-excellence-through-competitive-public-funding


### Characteristics of the Centres of Excellence under the RCE programme, Singapore

<table>
<thead>
<tr>
<th>Centre’s Name</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Earth Observatory of Singapore</td>
<td>Located in the NTU, the Observatory began operations in late 2008. Their research focuses on earthquakes, volcanic eruptions, tsunamis, changing sea levels and climate change in Southeast Asia. The director, Professor Kerry Sieh, was previously at the California Institute of Technology.</td>
</tr>
<tr>
<td>Centre for Quantum Technologies</td>
<td>This centre is affiliated to NUS and was the first centre of the programme to be established, in late 2007. Its experimental laboratories bring together quantum physicists and computer scientists to explore the interactions between atoms and photons, with possible applications to new forms of computing and communication. The director, Professor Artur Ekert, was brought from Oxford University.</td>
</tr>
<tr>
<td>Cancer Science Institute of Singapore</td>
<td>The centre is affiliated to NUS and was launched in late 2008. It conducts research into new treatments for cancer and is led by Professor Daniel Tenen, recruited from Harvard University.</td>
</tr>
<tr>
<td>Mechanobiology Institute</td>
<td>Ascribed to NUS, the Institute opened in 2009. It aims to develop a new paradigm for the study of diseases focused on mechanical cells and tissues. Its director, Professor Michael Sheetz, comes from Columbia University.</td>
</tr>
<tr>
<td>The Singapore Centre on Environmental Life Sciences Engineering</td>
<td>This is the newest centre, created in April 2011 and located within NTU. It aims to provide practical solutions to address environmental challenges based on complex microbial communities organised as biofilms. Its director, Prof. Staffan Kjelleberg, comes from the University of New South Wales.</td>
</tr>
</tbody>
</table>

Source: Prepared by the authors with information from the National Research Foundation
Table 14. Details of the research centres of foreign universities attracted by the Singapore CREATE programme

<table>
<thead>
<tr>
<th>University and Country</th>
<th>Descriptions of its research centre in Singapore</th>
</tr>
</thead>
<tbody>
<tr>
<td>Massachusetts Institute of Technology (MIT), USA.</td>
<td>In 2007 MIT established in Singapore its first research centre outside its campus in Massachusetts. Under the name “Singapore-MIT Alliance for Research and Technology (SMART),” the centre remains the most important of the MIT centres abroad, and has five groups of interdisciplinary research in the following fields: 1) infectious diseases; 2) sensors and environmental standards; 3) biosystems and micromechanics; 4) urban mobility of the future; and 5) low energy consumption electronic systems.</td>
</tr>
<tr>
<td>Swiss Federal Institute of Technology (ETH), Switzerland</td>
<td>The &quot;Singapore-ETH Centre (SEC) for Global Environmental Sustainability&quot; focuses on research into the cities of the future, integrating different disciplines such as engineering, environmental technology, communications technology, architecture, and material sciences.</td>
</tr>
<tr>
<td>Technical University of Munich, Germany</td>
<td>The TUM CREATE Centre is dedicated to research on electric mobility, with an emphasis on tropical mega-cities and the study of specific applications for Singapore.</td>
</tr>
<tr>
<td>Technion-Israel Institute of Technology, Israel</td>
<td>Technion-CREATE is a research centre that focuses on regenerative medicine. Their work has focused so far on cardiac restoration therapy through tissue engineering.</td>
</tr>
<tr>
<td>Hebrew University of Jerusalem, Israel</td>
<td>This centre conducts research into the cellular and molecular mechanisms of inflammation, with the aim of developing new diagnostic indicators and therapies for common inflammatory diseases.</td>
</tr>
<tr>
<td>Ben-Gurion University, Israel</td>
<td>Here the research is into new nanomaterials for their application to improving energy and water management systems.</td>
</tr>
<tr>
<td>University of California, Berkeley, USA.</td>
<td>The “Berkeley Education Alliance for Research in Singapore (BEARS)” has two research programmes: 1) development of innovations in the design and construction of buildings to improve their energy efficiency; and 2) development of low cost solar energy systems using abundant and cheap processes and materials.</td>
</tr>
<tr>
<td>Peking University, China</td>
<td>The &quot;Singapore Peking University Research Centre for a Sustainable Low-Carbon Future (SPURc)&quot; aims to develop new absorbent porous materials and bioreactors capable of separating and capturing CO2 and giving it an alternative use.</td>
</tr>
<tr>
<td>Shanghai Jiao Tong University, China</td>
<td>The &quot;Energy and Environmental Sustainability Solutions for Megacities (E2S2)&quot; programme is dedicated to the study of the environmental issues of urban agglomerations, such as decentralised waste and energy conversion systems to control and reduce environmental pollution.</td>
</tr>
<tr>
<td>Cambridge University, UK</td>
<td>The &quot;Cambridge Centre for Carbon Reduction in Chemical Technology (C4T)&quot; focuses on the assessment and abatement of the carbon footprint of the integrated petrochemical plants and electrical network on Jurong Island in Singapore.</td>
</tr>
</tbody>
</table>

Source: Prepared by the authors with information from the National Research Foundation.
Learning Model 3: Tax incentives for business innovation and new businesses: the French Young Innovative Companies Programme (JEI)

Programme description

The first French policies aimed at encouraging companies to engage in R&D through tax benefits were implemented in the 1980’s when the Crédit d ‘impôt Recherche (CIR) (Research Tax Credit) was established. This policy was later supplemented with new more ambitious public instruments designed to broaden the coverage and impact of the government’s stimulus to business innovation.

In 2004, the government established the Young Innovative Companies' programme (JEI), which created a set of incentives, compatible with those under the CIR, aimed at supporting the creation and launch of new R&D-intensive companies during the first seven years after its creation. This initiative made France the first country in the European Union to adopt such mechanisms, which proved to yield highly positive results in terms of generating new R&D-based companies; employment; and innovation-driven human capital; it also helped reduce the rate of failure of young firms.

The reason for including the JEI programme in this section lies in the fact that it pioneered the introduction of incentives geared to creating and supporting new STI-based SMEs.

Relevance to Medellin

The relevance of the JEI experience to Medellin has to do with the fact that replication and adaptation of such a programme to the city might prove beneficial. In France, JEI mainly favoured regions with installed R&D&I capabilities.

This means that, if a similar initiative were to be implemented in Colombia, one of the regions to reap the greatest benefits would precisely be the department of Antioquia, mainly because of the existing industrial base of its metropolitan territory, i.e. Medellin.

In the Colombian context, the national policy with respect to the award of tax benefits has been revamped in the past four years in two aspects of particular relevance to this case study:

- Colombia’s national tax benefit policy was modified in 2010 with the approval of the National Council for Tax Benefits (CNBT). The new policy incorporates a redefinition of the concept of innovation, the acceptance of investment in human capital, and a new definition of the types of eligible projects.  

- Modification of Article 158-1 (Taxation Statute for 2011) of Act 1450 (National Development Plan). Four major changes were introduced: new membership of the CNBT; adjustments to VAT exemption on imports; exemption from income tax on STI activities; and redefinition of tax deductions on investments and donations.

These changes respond to the government’s awareness of the need to strengthen measures aimed at encouraging and incentivising STI-based business activity, in order to meet the demands of the productive system. These initiatives have succeeded both in making public instruments more competitive and encouraging innovation across the business sector.

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86 The new policy was approved by the Advisory Board and the CNBT and endorsed under Act 1855 (December 2010).
87 CNBT’s Agreement 1 of 2011 defined projects in the STI category: 1) basic and applied research projects; 2) technological development projects; and 3) projects to develop innovative goods and processes.
While the new Colombian policy increases its scope with regard to the R&D chain, incorporating technological development and innovation (goods and processes), it does not include a particular element which, in the French case, made it possible not only to increase the number of new technology-based companies, but also, in the medium-term, to increase the government’s tax receipts and national insurance revenues from R&D-based SMEs aged 8 years or more.

The idea above is reflected in the following literal quote Kopp and Prud'Homme, shortly after the JÉI programme was implemented:

*The JÉI system will be costly to the State in terms of lost taxes and national insurance contributions. But at the same time, the programme will increase the State’s revenues. In other words, two contradictions will be at play. On the one hand, the reduction in tax receipts and national insurance contributions temporarily reduces the State's income and, on the other hand, the rapid creation of businesses and jobs quickly increases the State's tax receipts and national insurance revenues in the medium term.*

**Programme results**

JÉI is one of the most dynamic and competitive policy instruments developed in recent years by the French government to encourage innovation among SMEs. The review of the programme, conducted in 2012 by the General Directorate for Industrial Competitiveness and Services (DGCIS), reveals the following results:

- Since its inception in 2004, JÉI has been very successful with 4,500 firms created during this period. The programme allowed exemptions from taxes and national insurance contributions that only in 2010 amounted to EUR 134 million and EUR 20 million respectively. By sector, 84% of participating firms are in the service sector, dedicated to ICTs or other scientific and technological activities. Almost half of the JÉI firms are located in Ile-de-France, and more than a quarter in the Rhône-Alpes, Provence-Alpes-Côte d’Azur, Languedoc-Roussillon and Brittany regions.

- The programme helps companies reduce their skilled labour costs by 13% as firms benefiting from JÉI employ nearly 10 employees on average.

- JÉI has had a strong impact in terms of the number of R&D-related jobs created. In total, between 2004 and 2009, 20,000 jobs were created under the JÉI initiative; most of them (12,000) were a direct result of the programme. The remaining 8,000 jobs can also to some extent be attributed to JÉI, which has indirectly contributed to the survival of many firms.

**Key success factors**

One of the main reasons for JÉI’s success has been its compatibility with the R&D Tax Credit (CIR), which is at the heart of the operation of the programme. This tax credit is very attractive for innovative young companies as they can be reimbursed for the amounts declared, regardless of whether they had profits or losses during the relevant fiscal year.

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88 Impact Study of the profitability and financial stability of a typical innovative company in France. Carried out jointly by France Biotech and Ernst & Young in 2003.
Barriers and corrective measures

During its first two years of life, JEI did not result in the creation of many start-ups. That is why a supplementary programme was introduced in 2008, the "Young University Enterprises" (Jeunes Entreprises Universitaires, JEU) programme, which focuses on start-ups and spin-offs of universities. This allowed increasing the rate of growth of new businesses in the years following implementation.

Introduced by the Finance Act 2008 (equivalent to Colombia’s Budget Act), the JEU programme promotes entrepreneurship within the university community. The exemptions are equal to those under JEI, both in terms of taxes and national insurance contributions. They are also subject to caps, i.e. exemptions cannot exceed EUR 200,000 per each 3 fiscal-year period.

Considerations for potential adoption by Medellin and Colombia

A programme like JEI could only be imported by Colombia if its design were aligned with national policy regarding tax benefits and Act 1450. A new provision should be included in the latter concerning tax benefits for STI-driven young new businesses. This provision should be implemented in a new cross-nationally valid instrument developed by Colciencias. In this context, Ruta N could incorporate this instrument to its arsenal of measures to foster innovation, and assume the role of promoter and disseminator of the new tax benefits in the local environment.

Further reading


Learning model 4: Technology-Business Consortia (CTE), Chile

Programme Description

Chile’s Technology-Business Consortia are considered a pioneering initiative in the development of public policies to support and promote innovation in the country. Since their inception in 2004, the consortia have been implemented at a national level by the Chilean Economic Development Agency (CORFO), in coordination with its regional offices. These offices work in coordination with the planning departments of regional governments to orient corporate demand for STI-based products and services to each region’s strategic priorities. Several application rounds have been launched under the CTE programme, the last one in 2012-2013, which makes the Chilean example a very topical learning model. Technology consortia in Chile have gradually adapted to business needs. In fact, in the latest application round of the programme, public authorities have taken steps to encourage alliances between private actors that require innovative technological developments so that demand for R&D&I results from actual business needs rather than from university projects.

The CTE model provides funding for both the creation and the development of a consortium, with a view to executing R&D projects that may be applied in the interests of the business sector. Projects must be production-oriented and may be located in a specific territory, depending on each case. The commercial applicability of the potential outcomes is one of the selection criteria for research projects. Each project must have the potential not only to improve the economic performance of an enterprise in particular but of the industry as a whole.

Companies can participate as partners in the projects and establish a joint-execution contract or a sub-contract where the objectives are:
1. Development of innovation projects with a clear market orientation;

2. Early incorporation of technology partners and business projects agents;

3. Formation of alliances between national and/or foreign industry and technology partners; and

4. Formulation of business strategies based on innovative products and the results obtained from implementation of technology development and innovation projects.

The main components of the Chilean CTE model are summarised in table 19:

<table>
<thead>
<tr>
<th>Component</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Strategic focus of the consortium</strong></td>
<td>The strategic goal of the Programme is to cause sectoral impact, especially in subsectors of the economy that depend on the demand of STI-based products and services by business associations at national or regional level. The model does not require, and even actively discourages, that consortia have their own research centres. This implies that technology developments will be prioritised in terms of their prototype, scaling and go-to-market phases. Some applied research may be outsourced.</td>
</tr>
<tr>
<td><strong>Governance regime of the consortium</strong></td>
<td>Consortiums are made up largely of a set of firms with similar production activities that share the need to develop innovations. Universities, R&amp;D and technology transfer centres can join the consortium as partners. Each consortium appoints a Board of Directors made up of representatives from business and academia; which defines the strategic goals of the consortium; and makes decisions about the types of technology projects to be carried out, the amounts to be allocated to each, and the strategic alliances to be forged. Several consortia have created a Technical Committee composed of researchers and business professionals directly involved with the research. This Committee is appointed by the Board and its role is to oversee the research work that is underway; assess new research proposals; and make recommendations thereon to the Board. On the other hand, the Board appoints a manager to oversee and coordinate all activities necessary to implement projects and make sure that implementation proceeds according to plan. The manager administers the agreements between the consortium and R&amp;D centres to develop and transfer technology projects. He must also oversee the agreement between the consortium and CORFO throughout the duration of the grant.</td>
</tr>
<tr>
<td><strong>Funding</strong></td>
<td>Funding is based on contributions from public and private sources, with state contributions at around 50%. The programme finances the creation and development stages of the consortia. In addition, a temporary financing instrument has recently been introduced to ensure the medium-term sustainability of the consortia. Furthermore, consortia may finance their project portfolio with existing additional sources such as funds from the Tax Benefits Act (R&amp;D Act) and CORFO-sponsored instruments geared to business innovation in such areas as applied R&amp;D, business prototypes, technology partnerships and high tech business innovation, among others.</td>
</tr>
</tbody>
</table>
In Colombia, Colciencias designed a similar instrument in 2009 for creating technological development consortia. These consortia were in demand mainly by industries such as metalworking, plastics, leather and footwear, pulp and paper, etc. Although the model shares some similarities with the Chilean CTE programme, both programmes differ from each other because while the former, is open to the participation of a wide variety of players, including R&D centres devoted to the development of applied research projects geared to the industrial sector, the CTE programme is specifically aimed at the production of technology products and services in demand by industry, with consortia having a clearly-defined business bias. This implies that activities financed by the consortium must exclusively be geared to the management and development of applied business technologies rather than (basic or applied) research activities.

The results of this instrument, in its latest version, are still preliminary for Chile; however, is already possible to analyse and systematise a few trends regarding the achievement of the goals established.

Relevance to Medellin

The relevance of the Chilean CTE programme is that it has proven to be an effective mechanism in achieving a match between supply and demand of R&D&I-derived goods and services by the business sector. It has also succeeded in promoting technological development in specific sectors producing collective, sectoral and regional benefits.

The Colombian institutional framework, where different departments have developed channels and instruments to promote regional innovation, makes it possible to adapt the Chilean consortium model so that it can be integrated with the current mechanisms provided by Innpulsa or Colciencias to promote STI in the business sector. The Department of Antioquia could participate in this adaptation process with funding from the royalties system.

Programme Results

In terms of results, although no assessments have yet been made of the results of the 2012-2013 rounds of applications, the impact of the previous versions (2004-2009) of the programme can be used to provide an approximate indication.

- It is expected that the instrument will increase the funds invested by firms in the consortia for technological development; improvements are also expected in sales; in the number of patents; in the commercialisation of new products and services; and in the self-sustainability of the consortia. In addition, the instrument is expected to bring about technological improvements; result in the creation of new products or the enhancement of existing ones; stimulate new business development; promote intellectual property; increase the availability of human capital; etc.

- In the period 2004 – 2009, 16 consortia were formed, with a total of 118 research projects and a total investment of approximately USD 7 million.

- The productive sectors associated with consortia are mainly agriculture, ICT, renewable energies and pharmaceuticals.

Eighteen applications were received for the last round of applications launched in the second half of 2013 and eight new business-technology consortia were created. These new consortia are expected to dedicate around USD 120 million within the next 10 years to various R&D projects. If this investment materialises, CORFO will have contributed 43% of the resources mobilised by the programme.
Key Success Factors

The reasons behind the success of this instrument, which in its last round of applications attracted a high participation of representatives of the business sector, are mainly related to the flexibility provided in creating business consortia. Specifically, the programme is successful because:

- It allows co-funding to develop STI-based businesses, with a special focus on business demand.
- It effectively mobilises commitments and business investment agreements.
- It is a tool promoted jointly by four agencies, CORFO, Innova, Conicyt and FIA (Foundation for Agricultural Innovation).
- The instrument has incorporated improvements in its funding mechanism in order to allow the sustainability of young consortia.
- It is complemented with other business innovation instruments.

Barriers and corrective measures

Two shortcomings of the instrument were addressed in the early phases of implementation, which helped avert problems that might have threatened the achievement of the objectives of the consortia and reduce value creation. The first relates to the difficulty of establishing common goals between companies and universities. In response to this concern, the consortia themselves created the figure of the Technical Committee to establish criteria and lay down R&D&I guidelines, which must be approved by the Board. On the other hand, economic sustainability has been one of the most significant challenges for consortia. Today there are some consortia with minimal or no activity, and consortia that have had to close down for lack of funding.

Given that public policy for promoting innovation in the business sector contemplates that consortia should become powerhouses of knowledge and innovation in the medium and long-term, a series of calls were introduced with the aim of supporting the continuity of the research projects that have shown positive results in terms of achieving their initial goals. The calls are also addressed to consortia that wish to support the continuation and consolidation of collaborative work between businesses and domestic and/or foreign technology centres, as well as the development of marketing strategies for the products and results already obtained.

Considerations for potential adoption by Medellin

Adopting a similar instrument in Medellin primarily requires institutional support for its administration. Ruta N could provide such support as an instrument of this nature would be in line with the principles of the STI plan. A prioritisation of tasks using cluster-based criteria may be in order.

Further reading

Learning Model 5: Mixed funds (FOMIX): Promotion of scientific and technological investment in Mexico

Programme Description

The Special Programme for Science, Technology and Innovation (PECiTI) 2008-2012, mainstay of Mexico’s scientific, technological and innovation policy, aims to strengthen the social appropriation of knowledge and innovation, and the public recognition of their strategic importance for the development of the country. Efforts to unite all stakeholders in the system (firms, higher education institutions, and public and private research centres), under the leadership of the central and municipal governments have resulted in the creation of the FOMIX mixed funds. These are a series of trust funds that bring resources contributed by CONACYT (National Science and Technology Council) together with funds provided by state and municipal governments.

FOMIX’s operations began in 2002 with a small number of governments. Currently the system provides funding in the 31 Mexican states and the federal district of Mexico City, as well as in three municipalities. This makes the Fund a key instrument for supporting science, technology and innovation in Mexico. Its great virtue lies in the fact that the goals and objectives of FOMIX for each state are defined by the local authorities themselves, including the state councils of science and technology (COECYT).

Since the Fund’s inception, promotion of regional scientific and technological development through FOMIX has been a shared priority of both CONACYT and the different states. The effort made by each state, despite the current environment of limited financial resources, has made FOMIX one of the most important instruments to support decentralisation of science, technology and innovation activities in the country.

The following table shows FOMIX’s main characteristics:

<table>
<thead>
<tr>
<th>Table 16. FOMIX’s main characteristics</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Component</strong></td>
</tr>
<tr>
<td>FOMIX’s strategic focus</td>
</tr>
<tr>
<td>Governance</td>
</tr>
<tr>
<td>Funding</td>
</tr>
</tbody>
</table>
Relevance to Medellin

FOMIX mixed funds, which arose from an effort to establish a decentralised funding system for STI, have been adopted by all Mexican states. Although some regions are more active than others, the instrument has been able to strengthen state and municipal institutions and develop the capabilities of regional innovation systems. The Funds also succeeded in raising supplementary private resources from the productive sector.

This experience is highly relevant for Colombia, as the government mechanisms for managing decentralised resources is similar in both countries. In this context, Medellin, as a municipality, could create its own mixed fund with contributions from its own coffers and from the central government.

Programme results

Until September 2013 Mixed Funds had generated investments totalling just under USD 670 million, which were applied to different projects. The distribution of the resources in summarised in the following table:

<table>
<thead>
<tr>
<th>Year</th>
<th>Conacyt</th>
<th>State</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>2002-06</td>
<td>80</td>
<td>59</td>
<td>138</td>
</tr>
<tr>
<td>2007</td>
<td>17</td>
<td>14</td>
<td>31</td>
</tr>
<tr>
<td>2008</td>
<td>73</td>
<td>40</td>
<td>113</td>
</tr>
<tr>
<td>2009</td>
<td>40</td>
<td>42</td>
<td>82</td>
</tr>
<tr>
<td>2010</td>
<td>52</td>
<td>34</td>
<td>86</td>
</tr>
<tr>
<td>2011</td>
<td>34</td>
<td>40</td>
<td>73</td>
</tr>
<tr>
<td>2012</td>
<td>34</td>
<td>30</td>
<td>64</td>
</tr>
<tr>
<td>2013</td>
<td>41</td>
<td>42</td>
<td>83</td>
</tr>
</tbody>
</table>

The total number of projects based on specific requirements stood at 5,489. Projects can be classified into the following priority areas:

Approximate figure based on an exchange rate of MXP 1 = USD 0.075
Figure 1. Distribution of projects in relevant areas

<table>
<thead>
<tr>
<th>Field</th>
<th>Percentage</th>
<th>Projects</th>
</tr>
</thead>
<tbody>
<tr>
<td>Engineering and Industry</td>
<td>28.8%</td>
<td>1,380</td>
</tr>
<tr>
<td>Biotechnology and Agriculture</td>
<td>21.9%</td>
<td>1,203</td>
</tr>
<tr>
<td>Multidisciplinary</td>
<td>12.0%</td>
<td>659</td>
</tr>
<tr>
<td>Social and Economic Sciences</td>
<td>10.4%</td>
<td>569</td>
</tr>
<tr>
<td>Medicine and Health</td>
<td>8.6%</td>
<td>474</td>
</tr>
<tr>
<td>Biology and Chemistry</td>
<td>7.6%</td>
<td>418</td>
</tr>
<tr>
<td>Humanities and Behavioural Sciences</td>
<td>5.8%</td>
<td>318</td>
</tr>
<tr>
<td>Physics, Mathematics and Earth Sciences</td>
<td>4.9%</td>
<td>268</td>
</tr>
</tbody>
</table>

Source: Conacyt's website, 2013 [www.conacyt.mx](http://www.conacyt.mx)

**Key success factors**

The success of FOMIX mixed funds in consolidating themselves as key instruments to promote STI-based investment lies in the fact that they help materialise the goals of the central government and the states in the realm of science, technology and innovation. Specifically, the factors leading to the success of the Funds have been the following:

- The Funds energise the relationship between the central government and the states: states participate in the scheme on the basis of a relationship grounded in co-responsibility and mutual trust.
- Knowledge-related requirements are defined locally on the basis of the state's development priorities.
- Rounds of applications are designed on the basis of the states' development policies (National Development Plan, sectoral plans, National Science and Technology Plan); and are enriched by the participation of different sectors through consultation and decision-making mechanisms defined by the states themselves.
- The instrument has stimulated inter-agency and inter-institutional collaboration.

**Barriers and corrective measures**

Some of the barriers to the implementation of this public policy are those typically associated with decentralised investment mechanisms. They are related with the initial conditions and capabilities of the
states concerning their institutional structure and the governance of their innovation systems. This has resulted in situations where resources were assigned to projects without a clear orientation toward STI or to a host of small-scale projects whose impact was often unsatisfactory.

As the FOMIX mechanism consolidates, state governments are developing capabilities and governance strategies that allow them to identify specific STI-related demands, and address them even with private funding streams. This means that the total number of funded projects has gone down, but projects that do receive funding benefit from a higher amount of resources.

Considerations for potential adoption by Medellin and Colombia

Part of the reason why mixed funds could easily be adopted by Colombia has to do with the fact that the same decentralised mechanisms exist in both countries. That is to say, in Colombia the entity in charge of managing the funds at a national level would be Colciencias, which would conclude agreements with departmental and/or municipal governments for the establishment of the mixed funds. It would also be necessary to create a high-level committee, made up of representatives of all relevant sectors, which safeguards regional interests and defines specific priorities and requirements.

Further reading

Consejo Nacional de Ciencia y Tecnología, CONACYT, Gobierno de México. Website at: www.conacyt.mx

Learning Model 6: Innovative public procurement programme in Flanders, Belgium

Programme Description

With a population of about 6.3 million inhabitants, Flanders is the largest of the three regions comprising Belgium, the others being Wallonia and Brussels. The three regions are characterised by high autonomy in science, technology and innovation as well as high rates of investment in R&D (over 2% of GDP in recent years). Flanders has an ambitious development strategy which aims to position the region as one of the five most innovative regions in the European Union by 2020 (Cincera, 2013).

In 2009 Flanders was the first region of the country, and also one of the first in the EU, to develop an innovative public procurement programme, whose management was entrusted to IWT, the Flemish innovation agency. 90 This programme focuses on pre-commercial public procurement of R&D, through a sequential process whereby selected companies or R&D centres must develop R&D products, services or processes that do not exist in the market, and which may help address major social challenges (e.g., ageing, mobility, health, global warming) and/or improve the efficiency of public services. The programme was launched with the creation within IWT of a so-called Knowledge Centre for Innovative Procurement comprising a multidisciplinary working group, including a lawyer, an innovation specialist, technology experts and project managers. The next step was to promote conversations between various ministries aimed at identifying their public procurement needs. Thirteen priority areas emerged from these conversations, each being assigned EUR 1 million for the first pilots for an initial period of two years. For each of these priority areas a contact person was appointed, with the aim of coordinating the selection of projects in that area.

Once these 13 priority areas were selected, a methodology to articulate an innovative public procurement process was developed, which can be divided into 3 phases:

Phase 1. Establishing a platform for innovation and market consultation (3 to 6 months)

For each selected project an "innovation platform," coordinated by IWT, was established with the aim of finding solutions to social challenges through market consultations and technical discussions between the public purchaser and the participating companies and R&D centres. The objective was to maximise coordination and exchange of knowledge between supply and demand, so that bidders receive all they require from the ministries and specifications for products and services are clear. At a first meeting, platforms should conduct a review of the state of the art, explore the solutions available in the market and determine whether additional R&D is necessary. That is to say, dialogue within the innovation platform is the basis for deciding whether a certain procurement call should pre-commercial (further R&D is necessary) or commercial (a solution already exists in the market). The process ends with a final report and the preparation of documents for a round of applications to select the companies and R&D centres that will participate in the next phase.

Phase 2. Pre-commercial public R&D procurement (6 months to 2 years)

The starting point is the publication of a public call that clearly defines the R&D goods or services that must be developed and the establishment of the conditions to be followed in selecting participating companies. The next step is to select the company or centre that is going to be entrusted with carrying out the necessary R&D activities. Each participant develops a prototype that is delivered to the government for testing. A co-funding mechanism is employed, whereby the government and participating companies share the risks of the required R&D investment. Before this pilot was introduced, a project that required extra R& D fell outside the scope of the public procurement legislation unless the services were paid entirely by the government and the results (intellectual property) were also attributed to the government. Nowadays, however, it is considered necessary for the intellectual property rights to remain, whenever possible, in the hands of the company, since there is no guarantee that the government will finally buy the product, and because the aim is to stimulate business innovation. The requirement is that during this stage it is established that at least two prototypes must be developed by two different companies for each product or service to be purchased. This phase of the programme is the longest and can last between 6 months and 2 years.

Phase 3. Ordinary public procurement phase

If a successful prototype has been completed by the end of the R&D phase, the government can launch the commercial procurement phase, which leads to the implementation of the innovative project, by publishing the specifications of the call. This phase is governed by the following principles: fixed price, fair competition and award based on the lowest-priced submission. Fair competition must be respected and transparent supplier selection mechanisms established. This means that companies that have participated in the pre-commercial phase should not be favoured over other companies that entered the competition in the commercial phase. The result is that companies participating in pre-commercial phase must find ways to recover at least part of the costs incurred through efficiency gains and the adoption of new technological capabilities to improve the performance of their products and services in the market. Furthermore, the pre-commercial public procurement contract could provide for payment of license fees for the use of the technology developed in the case that their project is not selected in the commercial phase.

Relevance to Medellin

Flanders' innovative public procurement programme is regarded as a successful experience and has served as inspiration to other European countries and regions. It also helps illustrate how innovative public procurement programmes can be articulated at the regional or local level, and not only by the National Government. The Flemish programme focuses on major societal challenges, as should also be done by
Medellin. The methodology developed for project selection and market consultations could be replicated by Medellin if it decided to launch an innovative pilot public procurement programme.

Results of the Programme

Until 2011, a total of 48 proposals were submitted for the 13 priority areas, among which 15 projects were selected and innovation platforms were created for each of them. The first project was a platform for e-books that served as a pilot for demonstrating proper functioning of the system. Subsequently many other projects were selected, such as a system for diagnosing children’s eye conditions; a cultural information and entertainment system; a project on the use of ICT in healthcare; a personal development plan for citizens; new smart suits for firefighters; a rechargeable electric bike system for public car parks; a public works system to minimise risks during excavations; hydrographic surveying systems for rivers and sea areas; a system to make greenhouse cultivation more sustainable; new self-learning and competence-based learning methods for schools; low-energy consumption systems for public buildings; etc. The programme is still underway. Further information is available on the following website: http://www.innovatiefaanbesteden.

Key Success Factors

The programme led to the creation of an efficient forum for public-private dialogue and to improved coordination between the supply and demand for innovation. This was achieved thanks to the good performance of the innovation platforms coordinated by IWT. In general, an appropriate methodology was developed that ensured proper functioning of the various stages of the process, promoting transparency but at the same time allowing maximum flexibility.

Barriers and corrective measures

Implementation of the Innovative Public Procurement Programme faced legal challenges in terms of ensuring compliance with the norms that safeguard fair competition and transparency in markets and in the allocation of public funding. Therefore, special attention was given to ensuring high standards of transparency in relation to R&D processes and to the procedures followed for the selection of participating firms. The communication requirements for innovative public procurement are stricter than those for traditional public procurement. The government has to consult the market in the pre-commercial phase to better understand the needs for innovative goods, services and processes and convey this information to businesses, sometimes years in advance, so that they can anticipate future needs.

Another challenge was the decision of who should be the depositary of the intellectual property resulting from the R&D effort. Some argued that intellectual property should be left in the hands of the government as it was the government that provided the funding needed to perform the R&D activities. Others argued that intellectual property should be owned by the companies as they too take on some of the risks and contribute part of the financing required by the project and, above all, enterprises’ innovative and competitive capabilities must be encouraged, for which reason it is important to allow them to unrestrictedly use the results of their R&D activities in other areas. Finally, the second option was chosen which, as noted in Chapter 5 above, is the generally recommended alternative.

Considerations for potential adoption by Medellin

The development of an innovative public procurement programme by Medellin requires a prior legal analysis to determine how such a programme would fit in with Colombia’s national and local public procurement regulatory framework.
As in the case of Flanders, where management of the programme was placed in the hands of the Flemish innovation agency (IWT), in Medellin the programme could be managed by Ruta N. However, developing the programme at a regional level, under a partnership between Medellin City Council and the Governorate of Antioquia, would probably help achieve greater critical mass and exert a greater impact on society.

It would be important to explore the possibility of resorting to the royalties system to help finance the launch of an innovative public procurement scheme in Medellin as a pilot that could subsequently be adopted by other regions. In any event, funding from the royalties system to this programme should be generic, allowing a certain freedom in the selection of projects to be funded through pre-commercial public procurement.

Further reading


Learning model 7: International R&D Centres of Excellence (Chile)

Programme description

One of the most remarkable policies geared to attracting international STI-based investment to Chile, is the Attraction of International R&D Centres of Excellence. The general purpose of the programme is to promote and consolidate the establishment of world-class organisations and companies dedicated to STI in Chile. The programme was created in 2011 by CORFO, the Chilean Economic Development Agency. The Programme was implemented in two strategic phases. The first phase sought to improve the competitiveness of Chilean productive sectors through generation of applied knowledge and the establishment of links between international scientific networks and local industry. The second phase aimed at stimulating international firms and corporations to develop technology-intensive products, services and processes from Chile.

During the first phase, between 2009 and 2011, four R&D Centres of Excellence belonging to flagship R&D powerhouses in their respective countries of origin established themselves in Chile. These were CSIRO (Australia), dedicated to STI in the mining sector; Fraunhofer (Germany), biotechnology and renewable energies; INRIA (France), ICTs and mathematical modelling; and Wageningen (the Netherlands), devoted to the food industry.

In its second phase, launched in 2011, the programme received 11 applications by international R&D centres of excellence interested in carrying out STI projects from Chile, basically aimed at the Latin American market. The present learning model will focus on this second phase with a view to analysing the elements of the Chilean Programme that may be used to influence the design of the public policies applicable to Medellin’s innovation system, especially in terms of attracting international firms and organisations.
The total cost of the International R&D Centre of Excellence Programme is of around USD 77.6 million, of which CORFO contributes USD 25.6 million (33%) and international companies USD 52 million (67%) for a 4-year period. In 2013, four R&D centres of excellence were awarded to international firms and corporations: GDZ Suez Laborelec, Telefonica, Emerson and Pfizer. The purpose of the programme has been to attract international R&D centres of excellence to Chile so as to carry out R&D, technology transfer and go-to-market activities in high tech areas that have a high national and international impact and may result in the reinforcement of national R&D capabilities. The main components of the Chilean International R&D Centres of Excellence programme are as follows:

Table 18. Main components of the Chilean International R&D Centres of Excellence programme

<table>
<thead>
<tr>
<th>Component</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Strategic focus</td>
<td>The programme is aimed at attracting world-class R&amp;D centres that import talent and capabilities from abroad to develop in Chile goods and services for the international market. Unlike the first round of applications, on this occasion there will be no special call for centres belonging to pre-defined productive sectors (clusters) but rather entities in every sector or field of knowledge, especially those which operate internationally and have links with local firms and technological partners.</td>
</tr>
<tr>
<td>Governance structure</td>
<td>The R&amp;D centre should be established in Chile through one of the following mechanisms: a) Constitution of a company in accordance with the laws of the Republic of Chile b) Creation of a foundation or corporation in accordance with the laws of the Republic of Chile The R&amp;D centre may submit its application together with at least one Chilean partner, which may be a public or private legal entity established in Chile and belonging to one of the following categories: Universities or vocational training institutions National technology centre Technology-intensive firms Optionally, one or more legal entities may participate as partners. Partners are national or foreign public or private legal entities, for profit or not-for-profit, that contribute the necessary resources for the development of the project, and whose priorities possibly coincide with those of the R&amp;D centre. R&amp;D centres must have a management committee endowed with the authority needed to ensure effective governance. The centre should also have a scientific advisory board and a business advisory board.</td>
</tr>
<tr>
<td>Funding</td>
<td>Subsidies granted by CORFO shall not exceed USD 8 million. The economic contribution for each international R&amp;D centre of excellence must be at least twice as much as the amount granted by CORFO. Complementariness with the Law on tax incentives for R&amp;D activity</td>
</tr>
</tbody>
</table>

The ultimate goal of the programme is to get the world's best centres dedicated to applied R&D and to technological transfer and diffusion to establish themselves in Chile. The 2014 budget provides USD 10 million to create 5 institutional centres of excellence and USD 4 million for 2 corporate R&D centres.  

91 Budget Law 2014, Ministry of Economy, Chile.
Relevance to Medellin

The case of the Chilean International R&D Centres of Excellence is presented as an example of the effective implementation of a programme aimed at attracting international investments in STI. The model is oriented towards attracting foreign capabilities and resources to Chile but imposes the requirement that partnerships be forged with local suppliers so as to energise the relevant local productive sectors. The relevance of the Chilean case to Medellin lies in the fact that although a series of incentives already exist to attract anchor firms and institutions to specific areas of the city, an additional subsidy such as that contemplated under the International R&D Centres of Excellence programme could make it even more attractive for large international companies to establish their R&D infrastructure in Medellin.

Programme results

It is expected that 6 to 10 new international R&D centres of excellence will be established in Chile between 2013 and 2014. In what follows a general description is provided of the centres selected further to the 2013 call as well as of their main goals:

Pfizer

In recent years, Pfizer has pioneered the development of drugs to fight cancer, making alternatives to chemotherapy and other traditional treatments available to patients. The R&D centre the corporation is expected to establish in Chile will precisely focus its activities on the field of precision medicine, which is quickly becoming a mainstay in cancer research. The total investment for the Chilean centre will be USD 21.5 million, of which CORFO will contribute 33% (USD 7 million).

GDF Suez-Laborelec

GDF Suez-Laborelec’s centre will concentrate on the development of solar energy and energy efficiency solutions. Its goal is to become a paragon in Latin America for R&D in renewable energies, generating knowledge and experience in this area. The total investment for this centre is expected to be 8.3 million, of which 33% will come from CORFO (USD 2.7 million).

Telefonica

Telefonica is a world-renowned company in the realm of telecommunications. Its R&D centre in Chile will direct its attention to ICT solutions and the development of smart cities, an initiative aimed at the integration of digital and sensing technologies within a city in order to allow a more efficient management of basic aspects of city life such as parking space availability, traffic management and environmental monitoring. The total investment for this project is around USD 24 million, of which CORFO will contribute 33% (USD 8 million approximately).

Emerson

The establishment of Emerson’s R&D centre in Chile falls within the government’s goal of creating a strategic hub for the metals & mining sector. Emerson’s centre will be working on developing new solutions for the mining industry with respect to process management, automation and network and environmental technologies. Total investment for this centre adds up to USD 23.8 million, of which 33% will come from CORFO (USD 7.9 million approximately).
Key success factors

Although, no evaluations have yet been made on the results of implementing the programme, several elements in the general Chilean context presage its success:

- Generally, Chile's current political and economic context provides competitive conditions to attract the STI-based investments and capabilities of large international companies;

- The International R&D Centre Excellence programme enjoys the support of agencies dedicated to promoting Chile internationally;

- Complementariness with the tax incentives under the R&D Law has been a critical factor influencing the decision of international entities.

The R&D centres already established are working on different R&D&I projects with large companies in the mining, energy, food, technology and biotechnology sectors, among others, to create solutions that may have an impact on global markets.

Barriers and corrective measures

One of the main barriers to the Programme was related to making sure it was widely disseminated to prevent specific companies from monopolising the subsidies. In this respect, the support of government agencies such as Pro-Chile and AGCI was enlisted from the very beginning to help promote the programme as widely as possible. An international promotional tour was also conducted, with the help of Chilean embassies in different countries, in order to hold meetings with prospective applicants (STI-intensive multinationals). Also, although both rounds of applications launched garnered great interest, the limited resources available made it impossible to fund a larger number of applications. On average, only 35% of the applications received from international companies were approved.

Considerations for potential adoption by Medellin

Given its scope and importance, this instrument could be replicated and implemented by Ruta N in the framework of an agreement either with Colciencias or Innpulsa. A round of applications could be launched, considering the strategic priorities established by Medellin and the Department of Antioquia. The call may be launched at an international scale, also working with the counterparts of Colciencias/Innpulsa in other departments of the country. In the implementation phase, Ruta N would act as an international promoter of the initiative, drawing on the support of ProAntioquia and the Chamber of Commerce of Medellin and Antioquia. In the later phases, it would also play an important accompaniment role, facilitating the insertion of the new R&D centres in the regional innovation fabric. Lastly, this instrument could be supplemented with other programmes aimed at attracting international investments in STI.

Further reading

InnovaChile de CORFO, Sub-Dirección de Transferencia Tecnológica. http://www.corfo.cl/programmes-y-concursos/programmes/atraccion-de-centres-de-excellence-internacional-en-id

92 Chilean International Cooperation Agency.
ANNEX B

PROMOTING THE DEVELOPMENT OF MEDELLIN’S INNOVATION SYSTEM

ACTION PLAN

Introduction

On the basis of the diagnosis and the recommendations aimed at developing the innovation policy for Medellin expounded in the OECD Review “Promoting the Development of Local Innovation Systems: the Case of Medellin, Colombia” the present Action Plan is proposed to guide the performance of activities required to put the recommendations made in the Review into practice.

An agreement was made with Ruta N’s team in Medellin not to discuss all of the recommendations in detail, but rather to select a limited number of them on the basis of their importance.

The process undertaken to draw up the Review can be divided into three phases:

· Mapping of recommendations;
· Analysis and prioritisation;
· Detailed description of the most relevant actions in the framework of the selected recommendations.

It should be said that the analysis and prioritisation process has resulted in the design of the Action Plan, or Roadmap. This means that the exercise was not aimed at establishing an absolute ranking of recommendations but, instead, as a framework to more clearly identify the actions that could be implemented more expeditiously in order to generate visible and tangible impacts in the relatively short-term.

This approach entails that the present Plan has a contingent rather than a systematic perspective. To be systematic, the Plan would require a specific operational and executive feasibility study whose level of detail definitely exceeds the scope of this Review which, as mentioned above, focuses on the formulation of political recommendations.

Therefore, the present Review is intended to formulate a pre-operational Action Plan, which precedes the operational definition of the specific actions that may be required. In itself this is a demonstrative rather than an exhaustive exercise aimed at providing a clear picture of the path that should be followed in order to implement the different actions under the prioritised recommendations. The first step in this exercise consists in the mapping the different recommendations delivered by the OECD expert team.
Main recommendations for Medellin’s innovation policy

**Human capital: key enabler for the regional STI system**

4. Develop an Action Plan for human capital
5. Strengthen coordination between the stakeholders of the educational sector
6. Generate STI-qualified human capital across the business sector
7. Generate a demand for innovation-prone human capital
8. Improve the match between supply and demand of qualified personnel

**Intensification of investments in R&D activities geared to the region’s socio-economic development**

9. Strengthen existing R&D groups and promote consolidation of centres of excellence
10. Foster social innovation as well as a closer correspondence between Medellin’s research agenda and the needs of the region of Antioquia
11. Improve multilevel coordination, particularly concerning the new STI fund
12. Promote internationalisation of the regional innovation system

**Encourage business innovation, support to entrepreneurs and participation of strategic players in STI activities**

13. Spearhead a Smart Specialisation Programme
14. Make the environment more conducive to highly innovative technology-based start-ups
15. Implement a regular co-funding programme for innovative projects submitted by SMEs and local social organisations
16. Develop highly innovative local suppliers who can cater for the needs of Medellin-based multilatinas and global companies
17. Promote the establishment and operation of triple helix technology programmes
18. Implement multilevel trust funds (mixed funds)
19. Establish and disseminate platforms that bring together the supply of smart capital with local business ventures of high growth potential

**Public policies aimed at boosting demand for innovative products and services**

20. Develop a new innovative public procurement programme

**Strategies to attract STI-intensive investments**

21. Strengthen and provide international guidance to the Medellinovation district project
22. Elaborate further on Medellin’s marketing strategy and international status as a destination for STI-intensive investment
23. Strengthen the international profile of Medellin’s Cooperation and Investment Agency, promoting closer links with Ruta N to attract STI-intensive investments
24. Deploy a plan geared to attracting, managing and retaining business and entrepreneurial talent
25. Attract international corporate excellence in STI
26. Reinforce Medellin’s leadership among Latin American cities in the field of urban development and quality of life
Analysis and prioritisation of recommendations with respect to previous conditions

The recommendations selected have been ranked according to the role they can play in the strengthening of the local innovation system. The ranking has taken into account their strategic scope (priority and relevance) and the prerequisites that must be met to execute each recommendation.

<table>
<thead>
<tr>
<th>Priority:</th>
<th>this is the priority conferred to each recommendation, and to the respective actions proposed in the OECD Review following the analysis carried out by the international expert team. Priority levels are assigned in accordance with the objective import of each recommendation derived from its expected direct or indirect impact (see relevance below) and taking into account whether fulfilment of such a recommendation is a prerequisite to address any of the other recommendations under the same heading:</th>
</tr>
</thead>
<tbody>
<tr>
<td>A:</td>
<td>high priority</td>
</tr>
<tr>
<td>B:</td>
<td>intermediate priority</td>
</tr>
<tr>
<td>C:</td>
<td>Low priority</td>
</tr>
</tbody>
</table>

| Conditions to be met: | these are the prerequisites to be met before carrying out the actions included in the recommendation. (e.g., relationship with high-ranking officials, involvement and engagement of other stakeholders, previous steps that need to be taken before action is possible, etc.). |

| Traffic lights indicate whether the prerequisite has been met (green); whether there is uncertainty about such a prerequisite (yellow); or whether the prerequisite has not been met and there are doubts that it can be met in a reasonable time-frame (red). |

| Relevance: | this is the relative importance assigned to the actions that must be performed in order to expect tangible results and the achievement of the main objectives under each recommendation. |

| In the table relevance is graded in the following way: |
| --- | --- |
| ↑ | Critical |
| * | Significant |
| ↓ | Minor |
## Recommendations and their relative priority

<table>
<thead>
<tr>
<th>Recommendation</th>
<th>Priority</th>
<th>Prerequisites</th>
<th>Relevance</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Human capital: strategic enabler for the regional STI system</strong></td>
<td></td>
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<td></td>
</tr>
<tr>
<td>Develop an action plan for human capital</td>
<td>A</td>
<td>Special focus on the development of human capital for STI. Available resources</td>
<td>The engagement of relevant local institutions is mandatory</td>
</tr>
<tr>
<td>Strengthen coordination between the stakeholders of the educational sector</td>
<td>A</td>
<td>The OECD Review on Colombia underscores this requirement National reference strategies Relevant institutions (Colciencias, SENA, etc.)</td>
<td>Useful precedents exist (CUEE, G8, Sapiencia Alliance)</td>
</tr>
<tr>
<td>Generate STI-qualified human capital across the business sector</td>
<td>A</td>
<td>The structure of available human capital does not match the needs of many of the firms</td>
<td>A shared institutional commitment is required by both council and departmental authorities</td>
</tr>
<tr>
<td>Generate a demand for innovation-prone human capital</td>
<td>B</td>
<td>The general conditions at the level of policies, strategies and institutions are favourable</td>
<td>Taking effective action requires a favourable reference framework that depends on the success of R1 and R2</td>
</tr>
<tr>
<td>Improve the match between supply and demand of qualified personnel</td>
<td>B</td>
<td>Relevant institutions with a solid background should bring their approach up to date</td>
<td>Dual training and cooperative higher education must be strengthened. The link between education and Resources are available to enhance support systems (apprenticeships, collaborative research)</td>
</tr>
<tr>
<td>Recommendation</td>
<td>Priority</td>
<td>Prerequisites</td>
<td>Relevance</td>
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<tr>
<td><strong>National framework</strong></td>
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<tr>
<td><strong>Local / departmental institutions</strong></td>
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<td></td>
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</tr>
<tr>
<td><strong>Technical feasibility</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Intensification of investments in R&amp;D activities geared to the region’s socio-economic development</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Strengthen existing R&amp;D groups and promote consolidation of centres of excellence</td>
<td>A</td>
<td>Some programmes require a new thrust and centres of excellence need more funds</td>
<td>A will is required to establish synergies and concentrate resources in a fragmented context, which may generate power struggles and political pressure</td>
</tr>
<tr>
<td>Foster social innovation as well as a closer correspondence between Medellin’s research agenda and the needs of the region of Antioquia</td>
<td>A</td>
<td>Greater stimuli are required to orient the national innovation system toward major social challenges</td>
<td>Significant experience both in Medellin and Antioquia, but stronger integration is required between municipal and departmental authorities</td>
</tr>
<tr>
<td>Improve multilevel coordination, particularly concerning the new STI fund</td>
<td>A</td>
<td>The STI fund has strengthened regional autonomy, but has not prevented fragmentation or narrowed existing regional gaps</td>
<td>Department-municipality coordination must be strengthened and consolidated</td>
</tr>
<tr>
<td>Promote internationalisation of the regional innovation system</td>
<td>B</td>
<td>Although Colciencias has launched new programmes to promote internationalisation of the system, such programmes still have access to limited</td>
<td>Internationalisation is being successfully pursued at local level, but existing international alliances and programmes must be reinforced</td>
</tr>
</tbody>
</table>
## Encourage business innovation, support to entrepreneurs and participation of strategic players in STI activities

<table>
<thead>
<tr>
<th>Recommendation</th>
<th>Priority</th>
<th>Prerequisites</th>
<th>Relevance</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Spearhead a Smart Specialisation Programme</strong></td>
<td>A</td>
<td>Smart specialisation is not a consolidated strategy in Colombia.</td>
<td>The STI Plan is an older document. The smart specialisation strategy is a logical development that strengthens the strategic approach taken by the city</td>
</tr>
<tr>
<td><strong>Make the environment more conducive to highly innovative technology-based start-ups</strong></td>
<td>B</td>
<td>Programmes that promote investments in STI (e.g.: tax incentives) are available and could be developed further</td>
<td>Strategies, agents and initiatives exist that can be tapped into, consolidated and enhanced</td>
</tr>
<tr>
<td><strong>Implement a regular co-funding programme for innovative projects submitted by SMEs and local social organisations</strong></td>
<td>B</td>
<td>The STI fund must be strengthened and oriented towards the R&amp;D initiatives of the business sector (see R9)</td>
<td>Apart from the launch of permanent rounds of applications, a more proactive attitude by companies (especially SMEs) should be stimulated with respect to R&amp;D investments</td>
</tr>
<tr>
<td><strong>Develop highly innovative local suppliers who can cater for the needs of Medellín-based multilatinas and global companies</strong></td>
<td>B</td>
<td>The general framework is favourable. Conditions exist that facilitate efficient action for the development of</td>
<td>The link between large innovative companies and their SMEs suppliers must be reinforced. The challenge lies in strengthening SMEs and their capacity to innovate so</td>
</tr>
</tbody>
</table>

### Recommendation
- **Encourage business innovation, support to entrepreneurs and participation of strategic players in STI activities**
<table>
<thead>
<tr>
<th>Recommendation</th>
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<th>National framework</th>
<th>Local / departmental institutions</th>
<th>Technical feasibility</th>
<th>Relevance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Promote the establishment and operation of triple helix technology programmes</td>
<td>A</td>
<td>Measures are required to build networks across the business sector and between firms, universities and local R&amp;D centres</td>
<td>Local innovation agencies (Ruta N, Tecnova, and CUEE) are the key enablers for the development of triple helix Enterprise-Technology programmes. Reinforcing links between components of the Triple Helix is required</td>
<td>The engagement and operational capacity of firms and other relevant institutions for the development of triple helix programmes is required</td>
<td>↑</td>
</tr>
<tr>
<td>Implement multilevel trust funds (mixed funds)</td>
<td>A</td>
<td>Regulatory and operational conditions that make it possible to overcome restrictions inherent in conventional public financial mechanisms are required. However, Act 1289 created the FJ Caldas fund, to be administered by Colciencias, which could be used under an agreement with Ruta N or any other entity designated for this purpose</td>
<td>A greater capacity of action is required to have access to multilevel (national, departmental and local) contributions and public and private resources</td>
<td>Leading local companies exist that contribute funds for R&amp;D&amp;I</td>
<td>☆</td>
</tr>
<tr>
<td>Establish and disseminate platforms that bring together the supply of smart capital with local business ventures of high growth potential</td>
<td>A</td>
<td>General framework conditions are favourable to the dissemination of capital supply and demand platforms</td>
<td>The establishment of private investment funds has resulted in a significant supply of venture capital, a necessary condition to make venture capital</td>
<td>The deal flow of eligible business projects must be significantly increased overcoming considerable information gaps. Ruta N is already in the process of developing a strategy based</td>
<td>↑</td>
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</tbody>
</table>
### Public policies aimed at boosting demand for innovative products and services

<table>
<thead>
<tr>
<th>Recommendation</th>
<th>Priority</th>
<th>National framework</th>
<th>Local / departmental institutions</th>
<th>Technical feasibility</th>
<th>Relevance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Develop a new innovative public procurement programme</td>
<td>A</td>
<td>No national innovative public procurement programme exists</td>
<td>Some programmes related to public procurement of technology at local level have already been successfully developed. An installed capacity for managing complex procedures as well as more transparent local institutions is needed</td>
<td>↑</td>
<td></td>
</tr>
</tbody>
</table>

### Strategies to attract STI-intensive investments

<table>
<thead>
<tr>
<th>Strategy</th>
<th>Priority</th>
<th>National framework</th>
<th>Local / departmental institutions</th>
<th>Technical feasibility</th>
<th>Relevance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Strengthen and provide international guidance to the Medellin innovation district project</td>
<td>A</td>
<td>General framework conditions are viable for the strengthening of the District</td>
<td>A convergent commitment of local institutions, particularly Ruta N, exists</td>
<td>The project is at the cutting-edge of urban interventions in Latin America. A contact network with international stakeholders has been established</td>
<td>↑</td>
</tr>
<tr>
<td>Elaborate further on Medellin’s marketing strategy and international status as a destination for STI-intensive investment</td>
<td>B</td>
<td>Colombia is committed to boosting the attractiveness of its STI-system to foreign direct investments</td>
<td>Committed institutions and success stories do exist. Nevertheless, the operational capacity of ACI must be reinforced and close coordination with Ruta N’s international cooperation agenda promoted</td>
<td>Highly specialised consultants in each target market are a prerequisite</td>
<td>★</td>
</tr>
<tr>
<td>Recommendation</td>
<td>Priority</td>
<td>Prerequisites</td>
<td>Relevance</td>
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<td></td>
<td></td>
<td>National framework</td>
<td>Local / departmental institutions</td>
<td>Technical feasibility</td>
<td></td>
</tr>
<tr>
<td>Strengthen the international profile of Medellin’s Cooperation and Investment Agency, promoting closer links with Ruta N to attract STI-intensive investments</td>
<td>B</td>
<td>At the level of national policy, Colombia is committed to strengthening the attractiveness of its STI-system to foreign direct investments</td>
<td>Inter-agency coordination and cooperation at local level need to be ameliorated</td>
<td>A general STI-driven strategic framework exists</td>
<td>⬤</td>
</tr>
<tr>
<td>Deploy a plan geared to attracting, managing and retaining business and entrepreneurial talent</td>
<td>A</td>
<td>Viable framework conditions</td>
<td>Coordinated and convergent action is required on several fronts by different institutions to establish favourable conditions across the board</td>
<td>Wide-ranging effective initiatives are required to establish attractive conditions: development of English-language skills and attractive infrastructures</td>
<td>⬤</td>
</tr>
<tr>
<td>Attract international corporate excellence in STI</td>
<td>A</td>
<td>Viable framework conditions</td>
<td>A strategic framework is required alongside an inter-agency commitment to orient relevant activities (see R11 and R20)</td>
<td>Positive precedents exist. Availability of resources to support STI-intensive capabilities. Best international practices in this area should be identified to obtain maximum impact and positive externalities</td>
<td>⬤</td>
</tr>
<tr>
<td>Reinforce Medellin’s leadership among Latin American cities in the field of urban development and quality of life</td>
<td>A</td>
<td>Viable framework conditions. An externally recognised and valuable reputational capital already exists</td>
<td>Long-term coordination between the City Council and other local institutions is required to combine investment plans with intelligent infrastructure and public service management systems</td>
<td>Medellin is recognised for its social innovation and enduring effort is required to narrow the existing gaps in terms of equity and access to opportunities still faced by the local community</td>
<td>⬤</td>
</tr>
</tbody>
</table>
Out of a total of 23 recommendations, 15 are considered to be priority A, and eight regarded as priority B. At the same time, of the 15 recommendations assigned priority A, 13 are deemed critical whereas the remaining two are considered of significant relevance. Although recommendations 16 and 18 are considered high priority and critically relevant, they can be regarded as being in the course of implementation under the leadership of Ruta N.
Main recommendations for the Action Plan

On the basis of the analysis carried out, 11 recommendations have been selected whose implementation time-frame is considered a priority and for which it is believed that conditions exist for effective concrete action to be undertaken quickly.

Furthermore, in accordance with the consideration made in the initial paragraphs of this Review, a criterion of demonstrative representativity was adopted. Also, an agreement was made to elaborate only on a limited number of recommendations. These are recommendations 3, 6, 7, 10, 14, 1, 21, 22, and 23; all of them classified as critical high priority recommendations. Recommendations number 8 and 15 are also included as they are considered to be high priority and of significant relevance.
## Recommendations

### Human capital: strategic enabler for the regional STI system

1. Develop an Action Plan for human capital
2. Strengthen coordination between the stakeholders of the educational sector
3. Generate STI-qualified human capital across the business sector
4. Generate a demand for innovation-prone human capital
5. Improve the match between supply and demand of qualified personnel

### Intensification of investments in R&D activities geared to the region’s socio-economic development

6. Strengthen existing R&D groups and promote consolidation of centres of excellence
7. Foster social innovation as well as a closer correspondence between Medellin’s research agenda and the needs of the region of Antioquia
8. Improve multilevel coordination, particularly concerning the new STI fund
9. Promote internationalisation of the regional innovation system

### Encourage business innovation, support to entrepreneurs and participation of strategic players in STI activities

10. Spearhead a Smart Specialisation Programme
11. Make the environment more conducive to highly innovative technology-based start-ups
12. Implement a regular co-funding programme for innovative projects submitted by SMEs and local social organisations
13. Develop highly innovative local suppliers who can cater for the needs of Medellin-based multilatinas and global companies
14. Promote the establishment and operation of triple helix technology programmes
15. Implement multilevel trust funds (mixed funds)
16. Establish and disseminate platforms that bring together the supply of smart capital

### Cross-cutting strategic goals

- Multilevel governance, smart specialisation
- Internationalisation; smart specialisation
- Social innovation; Multilevel governance
- Multilevel governance
- Smart specialisation
- Multilevel governance; smart specialisation; internationalisation
- Multilevel governance
### Recommendations

<table>
<thead>
<tr>
<th>Recommendations</th>
<th>Cross-cutting strategic goals</th>
</tr>
</thead>
<tbody>
<tr>
<td>Public policies aimed at boosting demand for innovative products and services</td>
<td>Social innovation; smart specialisation</td>
</tr>
<tr>
<td>17. Develop a new innovative public procurement programme</td>
<td></td>
</tr>
<tr>
<td>Strategies to attract STI-intensive investments</td>
<td></td>
</tr>
<tr>
<td>18. Strengthen and provide international guidance to the Medellinovation district project</td>
<td>Social innovation; internationalisation; smart specialisation</td>
</tr>
<tr>
<td>19. Elaborate further on Medellin’s marketing strategy and international status as a destination for STI-intensive investment</td>
<td></td>
</tr>
<tr>
<td>20. Strengthen the international profile of Medellin’s Cooperation and Investment Agency, promoting closer links with Ruta N to attract STI-intensive investments</td>
<td>Internationalisation; smart specialisation</td>
</tr>
<tr>
<td>21. Deploy a plan geared to attracting, managing and retaining business and entrepreneurial talent</td>
<td>Social innovation; internationalisation</td>
</tr>
<tr>
<td>22. Attract international corporate excellence in STI</td>
<td>Internationalisation; smart specialisation</td>
</tr>
<tr>
<td>23. Reinforce Medellin’s leadership among Latin American cities in the field of urban development and quality of life</td>
<td>Internationalisation; social innovation</td>
</tr>
</tbody>
</table>

**Detailed description of the selected recommendations**

For each of the 11 recommendations prioritised in this Review, the Action Plan specifies the activities that must be performed, the methods to be followed and the main stakeholders that should be involved.
### Recommendation 3: Generate STI-qualified human capital across the business sector

<table>
<thead>
<tr>
<th>Activity</th>
<th>Operational implementation</th>
<th>Stakeholders</th>
</tr>
</thead>
<tbody>
<tr>
<td>Establishment of an observatory, i.e. an articulated analysis, monitoring an evaluation system aimed at strengthening “strategic intelligence” with respect to human capital</td>
<td>Prepare an annual report on academic and labour-related gaps. Formulate a perspective analysis of the companies’ human capital needs, with a view to ensuring that human capital generation policies are based on a rational knowledge of current and future requirements. This Observatory should be coordinated with the national level so that the system is integrated and coherent.</td>
<td>CUEE G8 Business associations Medellin City Council Governorate of Antioquia Ruta N in conjunction with Colciencias, SENA, Ministry of Labour, and DANE at national level Secretariat of Economic Development ProAntioquia Knowledge brokerage agencies (Tecnova, CTA, etc.)</td>
</tr>
</tbody>
</table>
| Actions geared to “strong” innovative technology-intensive companies, strengthening the permanent link between the business sector and higher education institutions | Align the specialised training offer to the needs of the business sector:  
- Sign industry-university cooperation agreements to foster exchanges, mutual learning and apprenticeships throughout students’ university journey  
- Cooperative construction – between firms and academic institutions - of educational curricula that match the needs of the business sector  
- Design and implement continuous training and capacity-building programmes for company staff  
- Promote industry-university exchanges that facilitate mobility of researchers and of STI-qualified personnel in general between companies and reputed educational and academic institutions (development of collaborative innovation projects, vouchers, apprenticeships, etc.) | CUEE G8 Ruta N as a broker between firms and academic institutions |
| Actions focused on developing the human capital of SMEs that are “weak,” operate in traditional sectors; are in a transition phase; or have just been created | Three coordinated levels of action:  
1. Systemic action that encourages an open attitude to change across the business sector: awareness-raising and advocacy action (seminars, workshops, dissemination of best practices, diagnoses of the technological capabilities of businesses and their human resources in different industries, etc.)  
2. Strategic alliances with capacity-building institutions – especially SENA – to develop bespoke continuous training programmes for the different classes of personnel (entrepreneurs, managers, workers) on topics related to innovation and change | Ruta N SENA CUEE Sapiencia Alliance |
<table>
<thead>
<tr>
<th>Activity</th>
<th>Operational implementation</th>
<th>Stakeholders</th>
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<tbody>
<tr>
<td>3. Support services oriented towards promoting innovation across business sector both at collective level, favouring the creation of business alliances focused on the value chain, and at the individual level sensitising companies about the importance of innovation enablers (see R4) who will act as facilitators and catalysers of innovation processes</td>
<td>management</td>
<td>Ruta N SENA Sapiencia Alliance ANDI</td>
</tr>
<tr>
<td>Actions aimed at promoting and stimulating the strengthening of professional technical standards</td>
<td>These actions are crucial to counteract the inverted pyramid predicament. It is essential to orient the qualification of technical staff to the effective needs of the business sector. Amongst other things, this would lead to a greater appreciation of workers in technical jobs: • The range of professional-technical qualifications on offer must correspond to the needs of enterprises • A strategic alliance should be made between SENA and Ruta N (and possibly local vocational training institutions) to increase the range of professional qualifications available, especially in areas prioritised in the STI Plan, without forgetting the traditional sectors of the local economy • The work of technical workers should be socially and economically recognised. Awareness-raising actions should be organised by companies aimed specifically at enhancing the value of technical professionals (contests, awards for the most successful technicians, apprenticeship vouchers, etc.). Companies should also be encouraged to assign a gradually more attractive remuneration to this group of employees</td>
<td>SENA Sapiencia Alliance Comfama, Cesde, foundations, etc</td>
</tr>
<tr>
<td>Generation of cross-cutting capabilities</td>
<td>Implementation of programmes intended to develop competences required across all business sectors: entrepreneurship, languages, ICTs, and emotional intelligence. This could be included in the curricula of different academic programmes.</td>
<td>Higher education institutions SENA Sapiencia Alliance Secretariat of education Vocational training and human development institutions (Comfama, Cesde, foundations, etc)</td>
</tr>
</tbody>
</table>

Relevant examples and learning models:
- Dual vocational education and training systems of Germany and Denmark
- Co-operative education at the University of Waterloo in Canada
- Training of innovation enablers, (Canary Islands, Spain)
### Recommendation 6: Strengthen existing R&D groups and promote consolidation of centres of excellence

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<tr>
<th>Activity</th>
<th>Operational implementation</th>
<th>Stakeholders</th>
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<tr>
<td>Mapping of existing R&amp;D centres in Medellin-based universities and</td>
<td>Establish a dynamic platform with a complete directory of existing research groups, including their respective quality ratings and contact persons. Such a platform should be continuously updated so that it allows efficient communication between national and international research groups and centres. Dynamic and systematic articulation of the R&amp;D system.</td>
<td>Ruta N with the support of Colciencias</td>
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<td>strengthening research networks with a view to addressing market needs</td>
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<td>Advocate for the launch of a centres of excellence programme by the</td>
<td>The local centres of excellence programme should be articulated with its counterpart at the national level. The OECD Review of Colombia's Innovation Policy recommends restoring the national Centres of Excellence programme launched in 2007 but never really took off.</td>
<td>High level dialogue between STI officials from Medellin, Antioquia and the National Government</td>
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<td>National Government</td>
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<tr>
<td>Definition of a smart specialisation strategy</td>
<td>The development of a smart specialisation strategy (Recommendation 10) is a preliminary but necessary step on the way to selecting priority technological areas for centres of excellence. It would also be necessary to orient centres of excellence toward social innovation.</td>
<td>Ruta N with the support of CUEE, G8, Chamber of Commerce of Medellin and other stakeholders in the ecosystem. Governorate of Antioquia.</td>
</tr>
<tr>
<td>Provision of adequate funds to implement a local programme to</td>
<td>Adequate funds are necessary over a 10-year period. A formula could be articulated to assign part of the STI fund to this programme.</td>
<td>Ruta N, Medellin City Council and Governorate of Antioquia.</td>
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<tr>
<td>support centres of excellence</td>
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<tr>
<td>Creation within Ruta N of a programme management office</td>
<td>This office must assume an unequivocal leadership role and have access to sufficient resources to discharge its duties. At the same time, however, administrative cost control will be necessary.</td>
<td>Ruta N</td>
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<tr>
<td>Design of a call for the programme</td>
<td>The number of centres of excellence selected should be small as resources should be concentrated in just a handful of centres that boast a high potential to achieve a sizable critical mass. Eligible expenses should be carefully defined. These may include the creation of international networks, equipment acquisition, and hiring young researchers, among others.</td>
<td>Ruta N</td>
</tr>
<tr>
<td>Establish an active dialogue with universities and R&amp;D centres</td>
<td>Workshops as well as visits to leading research groups should be organised in order to advertise the programme and assist them in preparing their proposals.</td>
<td>Ruta N, with the support of G8 and all the local universities</td>
</tr>
<tr>
<td>Establishment of selection, evaluation and monitoring</td>
<td>Establishment of an independent evaluation committee made up of national and international experts from all priority areas. Clear and transparent criteria should be defined, which prioritise scientific excellence, internationalisation and relevance to local industry. Easily understandable follow-up and periodical assessment mechanisms should be put in place to take corrective action if necessary, and to ensure that the centres report on their activities to decision-makers and society at large.</td>
<td>Ruta N</td>
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<td>mechanisms</td>
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**Relevant examples and learning models:**
Research Centres of Excellence programme, Singapore
Chile's Millennium Science Initiative
Finland's Centres of Excellence programme
### Recommendation 7: Foster social innovation as well as a closer correspondence between Medellin’s research agenda and the needs of the region of Antioquia

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<tr>
<th>Activity</th>
<th>Operational implementation</th>
<th>Stakeholders</th>
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<tr>
<td><strong>Development of a joint social innovation strategy for Antioquia and Medellin</strong></td>
<td>The smart specialisation strategy for Medellin should be accompanied by a social innovation strategy that prioritises projects geared to solving serious social problems and promoting innovation at the base of the pyramid. Ideally, such a strategy should be formulated in conjunction with the Governorate of Antioquia. This strategy should also be integrated with other programmes at the national level such as those sponsored by the Vive Digital plan, the Social Prosperity Department, and the National Agency for Overcoming Extreme Poverty. This strategy should stimulate the formation of public-private platforms and programmes aimed at supporting existing initiatives to encourage social innovation, such as Antioquia’s ¿Quién se le mide? and Medellin’s Social Labs programmes. Efforts should focus on a series of priority areas such as those mentioned below, establishing links with priority clusters and key technologies for the smart specialisation strategy.</td>
<td>Ruta N Medellin City Council Secretariat of STI of Antioquia</td>
</tr>
<tr>
<td><strong>Promotion of innovation in the rural and agricultural sector</strong></td>
<td>Implementation of projects that promote and strengthen rural development and the rural sector from a science and innovation perspective. Some relevant examples are the following: 1. Use of ICTs to improve logistics systems in the region’s agricultural enterprises 2. New methods to boost energy efficiency in agriculture and mining 3. Use of sources of energy, like solar panels, that may provide rural areas that are poorly connected with distribution networks with greater autonomy. Processing and recycling of agricultural waste (e.g., from coffee plantations) as sources of energy Incentivise the potential flagship effect that large foodstuff companies from Medellin, such as Nutresa may have on the development and modernization of agricultural practices in the rest of Antioquia. In this respect, public-private alliances should be forged to encourage the contribution of these companies to social innovation.</td>
<td>Medellin City Council and Governorate of Antioquia Agricultural SMEs and multilateral food companies Universities and research groups</td>
</tr>
<tr>
<td><strong>Development of infrastructures to facilitate inclusion of disadvantaged social groups</strong></td>
<td>Medellin should keep up its efforts to recover public spaces and invest in new transport systems to connect the more disadvantaged areas of the city (the Metrocable cable railway, escalators, etc.). Public transport between Medellin and other cities of Antioquia should also be improved.</td>
<td>Medellin City Council and Governorate of Antioquia</td>
</tr>
<tr>
<td><strong>Promotion of city-region collaborative innovation programmes in the health sector</strong></td>
<td>Promote telemedicine to extend public health coverage to the region’s rural population. Develop innovative applications to support telemedicine through smartphones. Enhance medical and pharmaceutical research to harness the region’s biodiversity.</td>
<td>Ruta N Medellin City Council and Governorate of Antioquia</td>
</tr>
<tr>
<td><strong>Encouragement by Medellin of the use of ICTs to support human capital and entrepreneurship in Antioquia</strong></td>
<td>Develop internet stations and innovative e-learning platforms, support entrepreneurship, etc. In order for Medellin to help develop the human capital of the rest of Antioquia, Universities and other educational institutions of Medellin should participate in the development of infrastructures, platforms, contents, and educational programmes Training should focus on promoting entrepreneurship and social innovation.</td>
<td>Medellin City Council and Governorate of Antioquia Universities of Medellin Vive Digital Plan</td>
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</table>

Relevant examples and learning models:
**Recommendation 8: Improve multilevel coordination, particularly concerning the new STI fund**

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<tr>
<th>Activity</th>
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<tr>
<td>Enhancement of the National Government’s support to the regions for the design of regional STI strategies</td>
<td>Regions require further support to be able to design strategies and submit projects to the STI fund. Moreover, a higher level of national coordination is necessary to detect duplicities in regional plans, identify cooperation opportunities and disseminate best practices that could be applied to various regions.</td>
<td>Colciencias and National Planning Department</td>
</tr>
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| Creation of new mechanisms to incentivise the establishment of thematic networks that promote inter-regional cooperation | Promote projects whose impact is not dependent on the city or region where they are developed. This would make it possible to harness the installed capacity in the cities and increase project effectiveness. Encourage the development of collaborative projects between regions. In addition, OCAD’s evaluations could make cooperation in areas where overlaps are found obligatory in order to exploit synergies. Strengthen participation of CUEE and the support of chambers of commerce and employers associations in the initial evaluation of projects. | Colciencias and National Planning Department                                                                                                         | Governorates
|                                                                                                                      |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       | Ruta N                                                                                                                                         |
| Improvement of the current monitoring, follow-up, control and evaluation System for the STI fund | Establish more efficient and transparent mechanisms for selecting, following up and evaluating projects, introducing interim evaluations and early alert mechanisms. Improve the IT tool (Gesproy) used for managing and monitoring project implementation.                                                                                                                                                                                                 | Colciencias and National Planning Department                                                                                                                                                             |
| Establishment of a new mechanism enabling OCAD to renew aid to the best performing projects | The idea would be to introduce an automatic grant renewal system so that applicants do not have to go through the department’s bureaucracy every time. The best projects should enjoy more stable funding so that they are not affected by changes of government.                                                                                                                                                                                                 | Colciencias and National Planning Department                                                                                                                                                             |
| Establishment of a clearer and more stable collaboration system between Medellin City Council and the Governorate of Antioquia for articulating and selecting projects | The Mayor of Medellin and the Governor of Antioquia agreed to distribute the funds of the royalties system equally between Medellin and the rest of the department. However, no guarantee exists that this system will continue in the future. Therefore, it would be desirable to clarify the institutional framework that will prevail in the future. Agree to a Regional Pact that guarantees the long-term stability of the relationship between Medellin and Antioquia on the basis of a new management system for the STI fund. | Governorate of Antioquia, Medellin City Council and Ruta N                                                                                      | Chambers of commerce
|                                                                                                                      |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       | ProAntioquia G8                                                                                                                                      |
### Activity: Introduction of more transparent and competitive project selection criteria in Antioquia and Medellin

**Operational implementation:**
Until now the project selection process has been somewhat chaotic. A better definition is needed of both the substance and the form of successive rounds of applications and their selection criteria. Generate mechanisms to ensure that a percentage of the STI fund is devoted to collaborative projects with enterprises.

**Stakeholders:** Governorate of Antioquia, Medellin City Council and Ruta N

### Recommendation 10: Spearhead a Smart Specialisation Programme

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<th>Activity</th>
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<tr>
<td>Establishment of a strategic orientation council that brings together Medellin’s government, industry, academia and civil society.</td>
<td>The Secretariat of Economic Development of Medellin has created a strategic council for the Smart Specialisation Programme made up of prestigious figures including a representative of the Medellin Chamber of Commerce. The Council’s function is to come to a consensus on the strategic priorities of the programme. In summary, the Council should meet quarterly to receive information about the developments achieved in the Smart Specialisation Programme. Ruta N could act as Technical Secretariat of the Council to guarantee that the agreements adopted are put into effect. The initiative proposed to the Council are those defined in the STI Plan.</td>
<td>• Secretariat of Economic Development of Medellin City Council • Ruta N (Technical Secretariat) • Strategic orientation council for KETs or RIIs convened by the Mayor through the Secretariat of Economic Development</td>
</tr>
<tr>
<td>Undertaking of a joint process aimed at defining and establishing the key priorities for innovation in science and technology</td>
<td>Promote prioritised strategic areas for these markets and constitute a triple helix governance space through regional innovation initiatives (RIIs), which should be organised into committees tasked with leading the participative design process and subsequent roadmap implementation. The clusters will then channel investments into the strategic areas previously identified by RIIs. Promote the creation of cross-cutting knowledge-based companies that cater for the needs of both the clusters and the market.</td>
<td>• Ruta N • Entities of the regional innovation system relevant for each KET sector • Business groups relevant to the sector • Regulatory entities relevant to the sector • Governorate of Antioquia • Medellin City Council</td>
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<tr>
<td>Validation of the commencement stage of the project and diagnosis</td>
<td>Formulation of terms of reference, and engagement (through a tendering process) of specialised consultancy firms to make diagnoses of goals and competitive gaps, which</td>
<td>• Ruta N</td>
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<td>Activity</td>
<td>Operational implementation</td>
<td>Stakeholders</td>
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| of existing gaps | is a prerequisite to draw up competitive roadmaps for each priority sector in the Smart Specialisation Programme. | • Specialised consultants  
• Governing bodies of each sector (KETs or RIIs) |
| Participative formulation of competitive roadmaps for each strategic priority (possibly including technological roadmaps) | On the basis of the diagnosis made and of the gaps identified, Ruta N must launch a tender for roadmap formulation. This involves the definition of priority action, terms of execution, duties of the different stakeholders and establishment of monitoring metrics. Roadmaps should be developed by specialists with extensive knowledge of the critical aspects of each sector; they should also be neutral with respect to the different participant stakeholders. This process should last at least 5 and 8 months in order to reach an appropriate level of detail and secure the involvement of the relevant players. | • Ruta N  
• Specialised consultants  
• Governing bodies of each sector (KETs or RIIs)  
• Secretariat of Economic Development of Medellin City Council |
| External roadmap validation | Each roadmap is validated by the Strategic Orientation Council for KETs or RIIs, convened for this purpose by the Secretariat of Economic Development. In this way, support mechanisms can be provided that make it possible to undertake the priority action established in each roadmap for the KETs or RIIs sectors. At the same time, a series of performance indicators are validated, which should be monitored regularly by Ruta N during implementation of each roadmap. | • Secretariat of Economic Development of Medellin City Council  
• Strategic orientation council for KETs or RIIs  
• Ruta N |
| Implementation of roadmaps (KET or RIIs initiatives) | Teams of consultants designated by Ruta N will be responsible for implementation of each KET or RII roadmap. The governing bodies of each sector will be the ultimate authority in this phase. In addition, once a year Ruta N will report on the progress of each roadmap to the Strategic Orientation Council for KETs or RIIs. Every two to three years, a review on the progress attained on the roadmaps could take place, which would involve an analysis of the milestones achieved. At this stage, a decision on the renewal of the initiative for the next year will be made. | • Ruta N  
• Governing bodies of each sector (KETs or RIIs)  
• Strategic orientation council for KETs or RIIs |

Relevant examples and learning models:
- **Medellin Ciudad Clúster programme**, Chamber of Commerce and Medellin City Council (direct precedent).
- **Rutas Competitivas para la Innovación Programme**, INNPULSA.
- **TEKES Technological Programmes** (Finland)
- **Innovation Program in Key Areas** (the Netherlands)
- **Smart specialisation Strategy Programmes**, CORFO (Chile)
Recommendation 14: Promote the establishment and operation of triple helix technology programmes

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<tr>
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<tr>
<td>In addition to the technological roadmaps to be formulated as part of the set of competitive roadmaps contemplated in the Smart Specialisation Programme, key stakeholders should be identified to participate in technology-industry programmes in each of the sectors defined in the Smart Specialisation Programme.</td>
<td>On the basis of the challenges and gaps identified in each roadmap, Ruta N may decide to launch rounds of applications prioritising the sector included in the Smart Specialisation Programme. The goal would be for initiatives to be submitted collaboratively between entities that offer or require STI. Permanently promote triple helix programmes to request technology-based products or services or jointly solve any problem that may be detected.</td>
<td>Ruta N&lt;br&gt;Entities proposing collaborative initiatives in priority sectors under the Smart Specialisation Programme</td>
</tr>
<tr>
<td>Evaluation of co-funding proposals.</td>
<td>Depending on the quality or relevance of the projects submitted, Ruta N, using its ordinary mechanisms and following consultation with the governing bodies of each KET or RII, will determine the beneficiaries of the co-funding scheme. Provide guidance and empower communities of stakeholders so that they can make operational decisions and work in close cooperation with each other on the challenges of the ecosystem without creating administrative red tape.</td>
<td>Ruta N&lt;br&gt;Bidding entities&lt;br&gt;Governing bodies of each KET or RII</td>
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<tr>
<td>Creation of project portfolios for each sector defined in the Smart Specialisation Programme, which will be managed as a sub-programme within the relevant smart specialisation roadmap.</td>
<td>Formulation of implementation agreements and management of integrated programme portfolios in the framework of the Smart Specialisation Programme. Given its brokerage function, Tecnovia can guide Ruta N in its endeavour to put together the project portfolios of each sector.</td>
<td>Ruta N&lt;br&gt;Project management teams&lt;br&gt;Governing bodies of each KET or RII&lt;br&gt;Tecnovia</td>
</tr>
</tbody>
</table>

Relevant examples and learning models:
- Regional Innovation Initiatives Programme (RIIs), Ruta N
- CRC Programme, Australia
- Technology-Business Consortia, Chile
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<th>Activity</th>
<th>Operational implementation</th>
<th>Stakeholders</th>
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<tbody>
<tr>
<td>Development of a pre-investment analysis, which (i) identifies trust</td>
<td>The Secretariat of Economic Development of Medellin City Council can manage the tendering</td>
<td>• Secretariat of Economic Development of Medellin City Council</td>
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<td>funds available at national level that could enable the establishment</td>
<td>and implementation processes of the analysis with a maximum budget of USD 60,000.</td>
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<td>and operation of a multilevel mixed fund to finance STI investment</td>
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<td>projects; and (ii) looks into the regulatory and legal conditions for</td>
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<td>each implementation</td>
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<tr>
<td>Formulation of an agenda for setting up a multilevel mixed trust fund</td>
<td>On the basis of the results of the analysis the Secretariat of Economic Development</td>
<td>• Secretariat of Economic Development of Medellin City Council</td>
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<td>identifies the priority areas and entrusts Ruta N with preparing a plan to setup a multilevel</td>
<td>• Ruta N</td>
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<td>fund that captures both public and private resources of multilateral (IDB, the Andean</td>
<td>• National and departmental counterparts</td>
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<td>Development Corporation, WB); bilateral (technical cooperation agencies such as GIZ, USAID);</td>
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<td>national (Colciencias, Innpulsa); departmental (STI fund), and local nature.</td>
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<tr>
<td>Promote the creation of new mixed funds</td>
<td>Constitute new mixed funds to promote diversified investment in innovation projects across</td>
<td>• Funds</td>
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<td>all their stages. These can vary as a function of the type of company, its level of</td>
<td>• Innpulsa</td>
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<td>development and its capital needs. Examples: private capital funds, angel investor</td>
<td>• Ruta N</td>
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<td>networks, promotion, mezzanine financing, loans, etc.</td>
<td>• National Planning Department</td>
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<td>• Secretariat of Economic Development</td>
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<td>• Banks</td>
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<td>• National Planning Department</td>
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<td>• Ruta N</td>
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<td>• Finagro</td>
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<td>Design of a strategy to encourage multilevel contributions that allow</td>
<td>The Secretariat of Economic Development, with the support of Ruta N, will establish a</td>
<td>• Secretariat of Economic Development of Medellin City Council</td>
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<td>implementation of the mixed fund</td>
<td>strategy intended to seek contributions from the sources identified at the different</td>
<td>• Ruta N</td>
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<td></td>
<td>governmental levels.</td>
<td>• National and departmental counterparts</td>
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<td>The first step of the strategy involves selecting an existing trust funds (e.g., FJ</td>
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<td>Design of a pool of agreements that makes it possible to assign the</td>
<td>Ruta N, in conjunction with each contributing entity, will prepare model agreements to</td>
<td>• Secretariat of Economic Development of Medellin City Council</td>
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<tr>
<td>resources in the mixed trust</td>
<td>regulate and specify the mechanisms whereby the mixed trust</td>
<td>• Ruta N</td>
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<td>• National and departmental counterparts</td>
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<td>fund to projects and initiatives relevant to Medellin’s STI strategy</td>
<td>The fund will operate and assign resources. The Secretariat of Economic Development of Medellin City Council should be part of, or at least periodically interact with, the Supervisory Council of the mixed trust fund, without prejudice of the specific regulations that govern each relevant fund. Establish a direct connection between mixed funds and the RII and finance projects prioritised by stakeholder communities.</td>
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<tr>
<td>Flexibilisation of the legal conditions of private funding instruments</td>
<td>Perform a study of the actual conditions to be met in order to access funding. The underlying purpose is to focus only on the indispensable conditions and flexibilise the legal conditions of private funding instruments.</td>
<td></td>
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</table>

City Council
- Ruta N
- Entities contributing to the mixed trust fund

Relevant examples and learning models:
- **Multilevel Structural Funds (EU)**
- **FOMIX (CONACYT, Mexico)**
- **Innovation Fund for Regional Competitiveness (Ministry of Economy and regional governments, Chile)**
## Recommendation 17: Develop a new innovative public procurement programme

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<tr>
<th>Activity</th>
<th>Operational implementation</th>
<th>Stakeholders</th>
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<tbody>
<tr>
<td>Development of new public procurement mechanisms that promote innovation</td>
<td>Each secretariat should identify the city’s challenges and problems on a specific budget and advertise them on platforms where national and international firms, research groups and universities can submit their proposed solutions.</td>
<td>Ruta N, Local government</td>
</tr>
<tr>
<td>Creation within Ruta N of a working group on public procurement and innovation</td>
<td>The group will be responsible for the design and follow-up of Medellin’s innovative public procurement programme. Under the leadership of Ruta N, the group should involve local public companies which, given their size and characteristics, could greatly stimulate demand-side innovation.</td>
<td>Ruta N and local public companies such as Metro and EPM</td>
</tr>
<tr>
<td>Development of a user-guide/operational manual</td>
<td>Two complementary handbooks could be prepared: one dedicated to government and the other to bidding companies. They would contain practical guidance and clear procedures so that all levels of local government incorporate innovation-related criteria in their tenders.</td>
<td>Ruta N in close collaboration with the Undersecretariat for Procurement and Contractual Performance of Medellin City Council</td>
</tr>
<tr>
<td>Awareness, training, and capacity-building plan</td>
<td>The plan would be intended both for government and for existing and potential bidding companies. The Public Procurement Fair organised jointly every year by the department and Medellin City Council would be an efficient platform to disseminate the manuals that are prepared.</td>
<td>Ruta N</td>
</tr>
<tr>
<td>Experimentation with pre-commercial public procurement processes through competitive dialogue</td>
<td>A first phase would involve a shortlisting of potential suppliers, with whom a closer dialogue should be undertaken to better identify the most appropriate solution to be subsequently integrated into the specifications of the tender. E.g.: Public Procurement Fair v 2.0</td>
<td>Ruta N and local public companies such as Metro and EPM</td>
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Relevant examples and learning models:
- ¿Quién se le mide? Programme (Antioquia)
- Innovative public procurement programme (Flanders, Belgium)
- Innovative public procurement programme (Spain)

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# Recommendation 21: Deploy a plan geared to attracting, managing and retaining business and entrepreneurial talent

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<tr>
<th>Activity</th>
<th>Operational implementation</th>
<th>Stakeholders</th>
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| Setting up of a Strategic Advisory Board made up of leading figures from the public, private and academic sectors who should act as ambassadors for the *Talento Medellín* initiative | Establish a period during which the Advisory Board must promote a strategic agreement aimed at attracting and generating scientific, professional and entrepreneurial talent for the local ecosystem. | Medellín City Council  
Chamber of Commerce  
G8  
CUEE  
ProAntioquia |
| Constitution of an Executive Secretariat for the *Talento Medellín* initiative, and design of a five-year action plan | On the basis of the strategic guidelines provided by the Advisory Board, the City Council must establish an Executive Secretariat for the initiative, whose first task should be to prepare an action plan within 4 months, which includes the different human talent segments that must be attracted and/or retained. | Medellín City Council  
Entity acting as Executive Secretariat of the *Talento Medellín* programme |
| Validation of the Action Plan and formulation of an internal and external dissemination strategy of the *Talento Medellín* programme | Once the *Talento Medellín* Action Plan has been prepared, it must be submitted to the Advisory Board for validation. Once it has been validated a strategy aimed at internally and externally disseminating the priorities of the plan should be deployed. | Executive Secretariat of the *Talento Medellín* programme  
Strategic advisory board for the Programme |
| Implementation of the Action Plan | The Executive Secretariat is responsible for executing the Action Plan, which should consider initiatives intended to repatriate local talent (PhD students studying abroad) and create a global network of leading foreign countries, amongst other priorities. | Executive Secretariat of the *Talento Medellín* programme |

Relevant examples and learning models:

**Similar initiatives in Israel, Korea, Mexico and Chile**
## Recommendation 22: Attract international corporate excellence in STI

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<tr>
<th>Activity</th>
<th>Operational implementation</th>
<th>Stakeholders</th>
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| Performance of a benchmarking and competitive intelligence analysis of policies aimed at attracting and incentivising corporate STI centres of excellence | ACI will be entrusted with the benchmarking study. Ruta N, la Chamber of Commerce, Tecnova and the Secretariat of Economic Development of Medellin City Council will provide support to ACI in this endeavour. | • ACI  
• Ruta N  
• Chamber of Commerce  
• Tecnova  
• Secretariat of Economic Development of Medellin City Council |
| Establishment of a framework of incentives and conditions to attract corporate STI centres of excellence | On the basis of the results of the comparative study, a system of incentives should be constructed to promote the establishment of R&D centres of excellence. A clear incentive strategy should be designed to attract national and international human talent from abroad in order to strengthen the excellence of corporate R&D centres. | • ACI in conjunction with Ruta N |
| Formulation of collaboration and performance agreements to maximise the synergies that each corporate STI centre can generate at the level of local innovation ecosystem | Promote the establishment of corporate R&D centres that conclude a collaboration and performance agreement with Ruta N aimed at generating synergies with the stakeholders of the local innovation system. Tecnova could play a brokerage role between these centres and local STI capabilities. | • Ruta N  
• Tecnova |

Relevant examples and learning models:
**Attraction of International R&D Centres of Excellence Programme (CORFO, Chile)**
**Recommendation 23: Reinforce Medellin’s leadership among Latin American cities in the field of urban development and quality of life**

<table>
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<tr>
<th>Activity</th>
<th>Operational implementation</th>
<th>Stakeholders</th>
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<tbody>
<tr>
<td>Systematic dissemination of the achievements attained by Medellin in the field of urban development, which reflect the relative strengths of the city</td>
<td>Preparation of a visibility strategy to advertise the relative strengths and merits of Medellin as a destination for innovative companies, dynamic entrepreneurs and centres of knowledge.</td>
<td>• ACI in conjunction with Ruta N</td>
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<td>Establishment of a public-private working group which should analyse the steps to be taken by Medellin to become a leader in the realm of urban development</td>
<td>Creation of a public-private inter-agency group to promote and spearhead enhancements in the following areas: connectivity, urban and suburban mobility, cultural offer, and public recreational and sporting faculties.</td>
<td>• ACI</td>
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<tr>
<td>Developing a national and international agenda of regular events associated with urban development, quality of life and the knowledge economy. Adequate national and international media coverage should be secured</td>
<td>Under the supervision of this public-private inter-agency group, promote Medellin as an appropriate venue for national and international congresses and events. Obtain institutional and private sponsorship and patronage, attract media coverage and coordinate the logistics of each event.</td>
<td>• ACI</td>
</tr>
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**Relevant examples and learning models:**
*Case studies from Barcelona, Bilbao, Vancouver, Toronto, from the 1980s to the present*
Conclusions

It is important, once again, to state that the activities and operational priorities, as well as the stakeholders whose involvement is required under this Action Plan, have been identified by an analysis by OECD experts. The findings of this analysis, however, must be considered preliminary, indicative and subject to review by the local stakeholders of Medellin, given their first-hand knowledge of local players and institutions.

The purpose behind providing a detailed analysis of each recommendation is to encourage a reflection process among local stakeholders, presenting them with some preliminary operational hypotheses aimed at orienting broad political principles toward specific action and offering relevant examples derived from pioneering international experiences. Details of these international examples are presented throughout the text and, particularly, in Annex A.

However, it is obvious that a more detailed design and implementation of the actions proposed herein cannot be carried out without a process involving local dialogue, analysis, verification and ex-post validation, which can only be performed in the specific context of Medellin. Undoubtedly, such a level of operational detail exceeds the scope of this OECD Review. This Action Plan, however, can serve as a useful starting point for a later phase in the process where reflexion and abstract recommendations would give way to the active implementation of specific actions.
PROMOTING THE DEVELOPMENT OF LOCAL INNOVATION SYSTEMS

THE CASE OF MEDELLIN COLOMBIA

This Review was prepared by the Centre for Local Development (LEED) of the Organisation for Economic Co-operation and Development (OECD) located in Trento, Italy, in close collaboration with Ruta N, the Agency for Innovation of the City of Medellin, Colombia.