International Development Working Paper

No. 2017-03
August 2017

Universities as the Engine of Economic Growth: Insights from Developing the First Industry–Higher Education Clusters in El Salvador

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August 2017

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A version of this paper was produced by RTI International for the El Salvador *Higher Education for Economic Growth* project *[Educación Superior para el Crecimiento Económico]*, funded under United States Agency for International Development (USAID) Contract No. AID-519-C-14-00004 (2014–2019). The purpose of the paper was to document the industry–higher education cluster model as part of the project's learning agenda in fiscal year 2017. The authors' views expressed in this publication do not necessarily reflect the views of USAID or the United States Government.

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ABBREVIATIONS

A4P	Alliance for Progress (framework)
AIRTO	Association of Independent Research and Technology Organisations
ASER	Salvadoran Renewable Energy Association *[Asociación Salvadoreña de Energías Renovables]*
ASI	Salvadoran Association of Industrialists *[Asociación Salvadoreña de Industriales]*
CAMAGRO	Agricultural and Agroindustrial Chamber of El Salvador *[Cámara Agropecuaria y Agroindustrial de El Salvador]*
casaTIC	Salvadoran Chamber of Information and Communication Technologies *[Cámara Salvadoreña de Tecnologías de la Información y Comunicaciones]*
GAP	Good Agricultural Practices
GMP	Good Manufacturing Practices
GOES	Government of El Salvador
HACCP	Hazard Analysis Critical Control Point
HEI	higher education institution
IAB	Industry Advisory Board
ICT	information and communication technology
IPR	intellectual property rights
IT	information technology
LEED	Leadership in Energy and Environmental Design
PROESA	El Salvador export and import promotion agency
R&D	research and development
RTI	RTI International (registered trademark and trade name of Research Triangle Institute)
STEM	science, technology, engineering, mathematics
SWOT	strengths, weaknesses, opportunities, threats
UDB	Don Bosco University *[Universidad Don Bosco]*
UES	University of El Salvador *[Universidad de El Salvador]*
UIC	university–industry collaboration
USAID	United States Agency for International Development

ABSTRACT

We explore the recent undertaking in El Salvador to establish the country's first industry–higher education clusters in four economic sectors critical to growth and competitiveness: (1) information and communication technology, (2) light manufacturing, (3) energy and energy efficiency, and (4) agro-industry and food processing. These clusters take a systems approach to aligning higher education institutions (HEIs) with the talent and research needs of the private sector. Under the United States Agency for International Development's *Higher Education for Economic Growth* project, RTI International designed and facilitated a three-phase, 10-step process, beginning with the careful and transparent selection of sectors, followed by early engagement of key stakeholders, to form clusters and establish formal structures necessary for sustained multisector dialogue. The discourse ultimately culminated in the creation of data-driven strategic and operational plans guiding cluster actions. This paper documents this detailed process and highlights early successes and challenges observed. Finally, learnings and insights are also offered for those wishing to undertake a similar systems-level approach to collaboration between HEIs and industry with the goal of producing tangible, sector-level economic benefits.

INTRODUCTION

Higher education is integral to creating a skilled workforce, encouraging innovation, and ultimately increasing prospects for growth in most economies. Whereas in the past, most economies were based on the production of labor-intensive commodities, today's global integration of economies requires a more educated and skilled workforce. Knowledge creation and management, information and communication technology (ICT), innovation, and research and development (R&D) are highly valued. Even industries that are already successful must innovate and invest in technology and a more skilled workforce to continue to compete. To do nothing is to become obsolete in the future.

Universities are similarly challenged to innovate to remain relevant and provide the talent that industry demands, as well as generate the knowledge that industry requires to remain competitive in a global economy. An "entrepreneurial university" is one that creates new revenue streams and strategies to bypass traditionally slow-moving, bureaucratic reform processes and to supplement scarce funds for industry-relevant research. Thus, industry and universities are both challenged to remake themselves in the 21st century and to do so together.

This paper addresses the issue of university–industry collaboration (UIC) in five parts. The first is a brief review of the literature on UICs, the entrepreneurial university, and why the vanguard organizations in the two sectors are knocking down barriers and creating a new collaborative culture. In the second part, we introduce the recent experience of El Salvador in establishing UICs and share the model for the theory of change. Building on the UIC literature, we introduce the concept of "industry–higher education clusters," or alliance-building between industry and multiple higher education institutions (HEIs), aimed at working together to meet industry's talent and research needs. In the third part, we address the processes, strategies, and structures of forming and operationalizing industry–higher education clusters. In the fourth part, we share some early success stories in implementation. Finally, in the fifth part, we offer lessons learned from our recent experience with the challenges in establishing industry–higher education clusters and ensuring that they are sustainable. We also share recommendations and specific strategies for policy makers and practitioners in other countries interested in replicating a similar model of industry–higher education collaboration.

Although the central focus of this paper is collaboration between industry and HEIs, we acknowledge that government also can play a crucial role in supporting the formation and operationalization of the clusters. In El Salvador, the government not only is responsible for the regulation of HEIs, but also must approve changes in curricula and degree programs. Therefore, the government's support and encouragement in fostering innovation in higher education is essential to operationalizing industry–higher education collaboration. In the formation phase, the government played an important symbolic role supporting and encouraging the formation of industry–higher education clusters. As Tierney (2014) noted, to meet the demands of rapidly changing knowledge-age economies, HEIs must "develop a culture of innovation in their organizations." The Government of El Salvador (GOES) plays a crucial role in facilitating the development of such a culture at the level of institutions and at the level of the higher education system nationally.

PART 1 – LITERATURE REVIEW

UICs have been covered extensively in the literature since the early 1990s. Ankrah and Al-Tabbaa (2015) recently completed a comprehensive review that identified over 1,500 published articles on the topic, of which they analyzed 109 in depth. Evidence has supported that companies that collaborate with universities show gains in productivity and improved competitiveness when compared to companies that lacked similar collaborative relations with HEIs (Malairaja & Zawdie, 2008). Such results have spurred governments in advanced and emerging economies to enact polices aimed at stimulating collaboration in research and development between industries and universities (Acworth, 2008; Salleh & Omar, 2013). However, less developed countries are not as well represented in the literature.

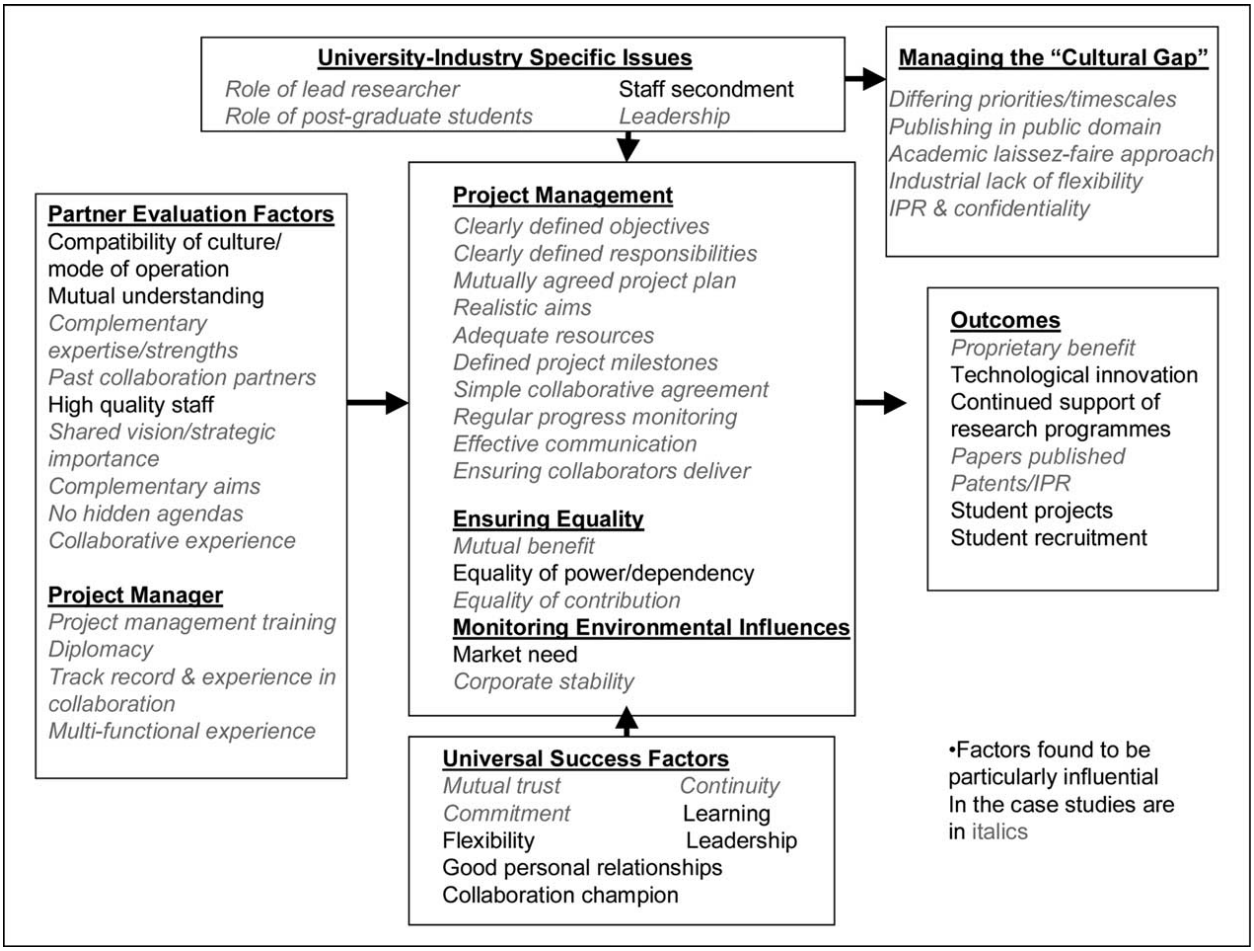
UICs are defined as rational, inter-organizational relationships that facilitate the exchange of resources (Ankrah & Al-Tabbaa, 2015). Resources may come in the form of tangible goods such as materials and equipment, as well as intangible goods such as knowledge and research. In either case, industries and universities engage in collaborative relations as a means of expanding access to resources (Association of Independent Research and Technology Organisations [AIRTO], 2001; Koka & Prescott, 2002).

UICs come in various modes of engagement. In a multi-case evaluation of UICs in the United Kingdom, Barnes, Pashby, and Gibbons (2002) identified four areas of possible collaboration: (1) consultancy, (2) product commercialization, (3) technology transfer, and (4) innovation and R&D. Each area differs in degrees of dependence on a continuum of interpersonal to inter-institutional relations or agreements.

The more complex the relationship, the more important the choice of partner. Barnes and colleagues identified the most salient characteristics of effective partnerships. At the top of the list were complementary objectives and expertise. Although individual interests might have differed (e.g., publishing research for the academic side, and solving production problems for the private sector), complementary objectives were necessary to drive collaboration. Other important factors were trust, the absence of evidence of a hidden agenda, prior collaborative experience, and continuity of personnel. Whatever the criteria for partner selection, Barnes et al. advised on establishing an objective and transparent process to evaluate prospective partners.

Following the formation of partnerships is operationalizing the collaborative activities. Managing cultural differences between universities and industries is among the first challenges UICs face. Misunderstandings can occur unless specific attention is given to agreeing on priorities and time lines. Perceptions about the rights to publish, confidentiality, and intellectual property are also potential fault lines. These and other findings led Barnes and colleagues to develop a "Good Practice Model for Collaborative Management." In addition to stipulating selecting a partner and managing the cultural differences, the model points to the importance of ensuring equality and mutual benefit, employing factors that contribute to universal success, agreeing beforehand on outcomes, monitoring environmental influence, and most importantly, reaching consensus on the role of the project manager and project management team (see Figure 1).

Figure 1. Good-practice model for collaborative management



Source: Barnes et al. (2002), p. 283; used by permission of Elsevier, publisher of *European Management Journal.*
IPR = intellectual property rights.

Ankrah and Al-Tabbaa's (2015) systematic review of UIC literature found that 45 percent of factors that facilitated or hindered UICs fell into the category of management and organizational issues. Mutual trust, commitment, teamwork, and a collaboration champion were among the factors that made up their management and organizational category. Similarly, Siegel, Waldman, and Link (2003) found that management and organizational issues were critical to the nature of the UIC. If there was a strong collaborative champion and UIC relations were formed based on trust and mutual respect, then many of the risk factors could be addressed collaboratively as well. Among the other factors that Siegel and colleagues found impacted UICs were capacity and resources, legal issues, political issues, social issues, technology, and human capital.

This paper contributes to the literature and addresses the underrepresentation of UICs in less-developed countries as a means of expanding private sector growth. The experience in El Salvador adds insights on industry–higher education collaboration around human capital, talent, curriculum, and internships in addition to applied research to promote innovation and increase industry competitiveness. Importantly, this paper adds a new dimension to the UIC literature by introducing the concept of

industry–higher education clusters in which multiple HEIs contribute resources to respond to industry needs and demands for more highly qualified talent.

PART 2 – EL SALVADOR CONTEXT AND THEORY OF CHANGE

The Case of El Salvador

Making the transition from an agrarian, craft-based, or light-manufacturing economy to a knowledge-based economy is especially important for a country such as El Salvador, in which growth has been impeded by lack of diversification. Its economy has traditionally been dominated by low-skilled, labor-intensive industries, particularly in manufacturing and agriculture. Universities and other HEIs are key actors in this economic transition, as they are both centers for producing knowledge and for equipping the public and private sector with the skilled labor required to push the economy forward.

El Salvador's budget for higher education represents only 1.7 percent of the total budget; in the field of education, higher education represents 9 percent of the budget.[1] Accordingly, given that higher education has consistently been a low priority for the government, there are few structural or market incentives for institutions to change and offer programs more relevant to market needs than currently exist, such that a skills mismatch persists. Instructors lack current knowledge in industry trends, are inexperienced in student-centered teaching methods, have few connections with employers, are unaware of in-demand competencies, and undertake limited research to facilitate development of specialized expertise. Not surprisingly, Salvadoran private employers report difficulty in finding new hires with appropriate technical, soft, and English-language skills; workplace professionalism; and realistic career expectations.

Meanwhile, students have continued to enroll in high numbers in traditional academic programs such as law, marketing, accounting, and social services. As of 2015, only 23 percent of students enrolled in higher education were in science, technology, engineering, or math (STEM) fields (Ministerio de Educación, 2016, p. 110). According to FEDISAL, most students, like their parents, are ill informed about the consequences of their career choices on employment and wage outcomes after graduation (FEDISAL, 2013). Exacerbating this frame of reference are the many HEIs that have limited institutional capacity in strategic planning, governance, fundraising and financial management, and other organizational management functions, including quality control of academic standards (Saunders et al., 2012). These factors further weaken the country's competitive position in the global marketplace; however, these conditions also present an opportunity to demonstrate how building the capacity of HEIs according to industry needs can create economic opportunity and growth.

In response to this need and the opportunity to demonstrate the role of industry–higher education collaboration in bringing about economic growth, the United States Agency for International Development (USAID) partnered with RTI International to implement the *Higher Education for Economic Growth* project. The five-year project, which began in June 2014, aims to build the human and institutional capacity of Salvadoran HEIs and enhance the efficacy of key government and higher

[1] Data calculated from the General Budget of the Nation 2017 *(Presupuesto General de la Nación 2017)*.

education entities to provide educational programs and research that contribute to the country's economic growth. The project also aims to strengthen Salvadoran HEIs to adequately respond to productive sector needs.

Industry Shares That It Needs a Strong Base of Educated and Skilled Workers

As part of the early design of the El Salvador project, RTI asked industry representatives to report on the types of skills and competencies required for entry-level workers in middle-skill and skilled occupations that could help enhance the sector's competitiveness.

Main Findings of Sector Selection Research: Top Human Capital Needs for El Salvador

- Labor force that is educated and skilled and has crosscutting skills relevant for all sectors, such as English language, soft skills, good manufacturing practices, engineering, and design and packaging, among others.
- Professionals such as engineers, workers in fields related to STEM, IT specialists, and a greater number of sector-specialized technicians (plastics technicians, food-processing technicians, quality-control technicians).
- An increased number of professionals with global certifications, particularly in ICT.

From a competitiveness and economic growth perspective, industry representatives shared that the country needed a labor force that was educated, skilled, and had crosscutting skills such as English and soft skills. Industry groups reported needing a combination of engineers, STEM-based workers, information technology (IT) specialists, and also more specialized technicians (e.g., plastics technicians, food processing technicians, quality control technicians, and others).

The country's lead manufacturing association, the Salvadoran Association of Industrialists (*Asociación Salvadoreña de Industriales,* ASI), emphasized the need to train and educate professionals and technicians in careers that are crosscutting to all sectors—for example, in areas such as good manufacturing practices, engineering, design and packaging, recycling, energy, and industrial production. Industry representatives reported the need for an increase in professionals with global certifications, particularly in the IT field.

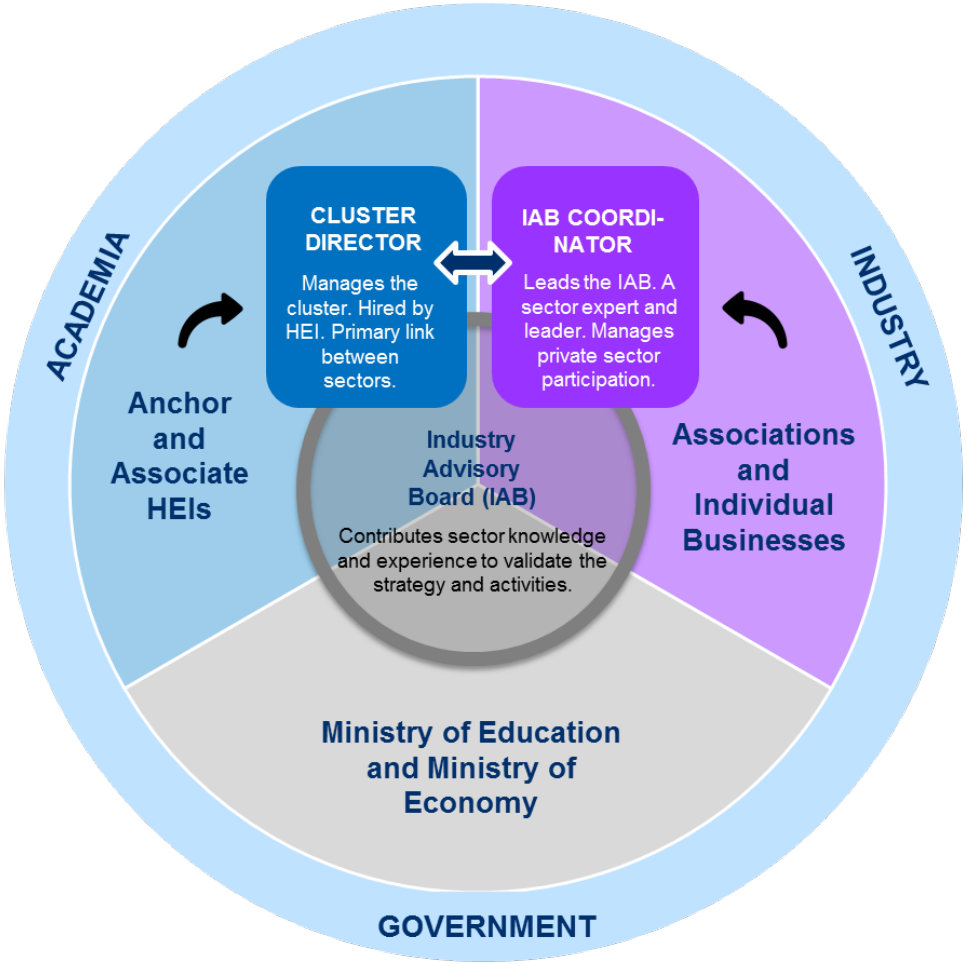
El Salvador's industry groups told the project research team that they believed an educated and skilled workforce would be critical to enhancing the country's economic competitiveness. These respondents expressed that developing industry–higher education alliances was a much-needed strategy for their country.

Model of Change – Industry–Higher Education Clusters

The mission of the *Higher Education for Economic Growth* project is to strengthen the science, technology, research, and innovative capacity in El Salvador's higher education, with a focus on disciplines that can contribute to high-growth economic sectors. The project is a key element of the U.S. Government's Alliance for Progress (A4P), which represents a framework for deepening and strengthening the U.S. and El Salvador bilateral engagement to promote economic growth. A4P's goal is to assist El Salvador's transition from a low-growth path to a higher, sustained growth trajectory in line with other high-performing emerging economies. This is important because it means that higher education reform is being approached first and foremost as an engine toward growth, with the economy as the ultimate driver.

Developing industry–higher education alliances, or clusters (see ***Figure 2***) is at the core of the project's model of change. The clusters—made up of academic institutions, industry, and government—provide a platform for implementing the project's activities and are expected to gradually become self-sustaining. The objective of the clusters is to foster collaboration on investments in talent development and applied research projects. Through this model, private sector associations, employers, HEIs, and government work together in structured partnerships to educate students for the competencies required for professional and technical careers in high-growth fields, as well as to develop scientific and technological solutions to industry challenges.

Figure 2. Industry–higher education cluster model



Source: *Created by Higher Education for Economic Growth* project team.

In the economics literature, clusters constitute an array of linked industries and other entities that enhance the competitiveness of industry (Porter, 1998). Their contribution to economic growth lies in the relationships, knowledge, and innovation that may be built, which distant rivals cannot match, thus creating enduring competitive advantage in a global economy. Efforts to develop industry clusters increasingly include HEIs as central assets. HEIs provide research and technology, prepare a qualified

workforce, and support development of entrepreneurial skills. The HEIs with the greatest impact are those with a robust base of research and/or education and technical training programs that are closely aligned with industry's demand for talent.

We argue that although ideally the entrepreneurial university would provide both research and talent aligned with industry needs, a systems perspective is needed in developing countries like El Salvador to ensure that the higher education system can deliver on the talent and research. The innovation in El Salvador was empowering a range of HEIs to make strategic investments in improving talent and/or research aligned with the needs of the cluster.

PART 3 – FORMATION AND OPERATIONALIZATION OF THE CLUSTERS

The process overseen by the *Higher Education for Economic Growth* project of forming and operationalizing industry–higher education clusters was divided into three phases of activities—Phase One: Forming Clusters; Phase Two: Operationalizing Clusters; and Phase Three: Ongoing Implementation.

Phase One involved identifying the high-priority economic sectors based on their potential for growth and degree of commitment to collaborate with HEIs to overcome barriers to competitiveness. In addition, Phase One included selecting the lead or "anchor" HEI for each cluster, as well as additional HEIs committed to participating in the cluster as "associate" members through collaborative working relationships at a sector-wide level.

Phase Two created the organizational and management structures cited as critical in the literature review for the industry–higher education clusters, and set up the clusters for sustainability beyond the life of the project. Operationalizing the clusters involved four key milestones: (1) forming an industry advisory board in each cluster, led by an industry leader as the coordinator; (2) having the anchor HEI appoint a full-time cluster director to serve as the cluster leader; (3) commissioning a sector-wide competitiveness study in each sector to identify barriers to competitiveness and potential solutions; and (4) bringing cluster partners together to form a common vision for the cluster and create a five-year strategic plan.

Phase Three revolved around enactment of the five-year strategic plan, which includes ongoing implementation of cluster activities. As part of this phase, grants are issued to recipients who aim to overcome obstacles to competitiveness and promote innovation.

Figure 3 illustrates the 10 steps followed across three phases of the cluster formation process. All three phases are described in detail in the following subsections.

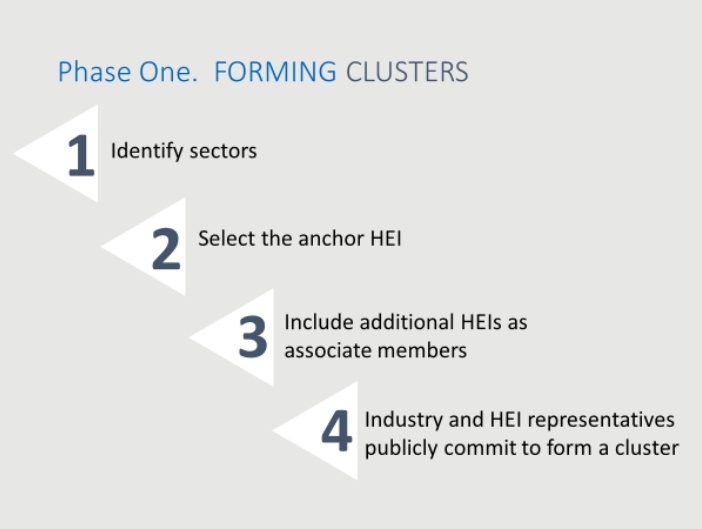
Figure 3. Phases of cluster formation

Source: Created by *Higher Education for Economic Growth* project team.

Phase One: Formation of Clusters

Phase One in El Salvador was characterized by the selection of high-priority economic sectors and their higher education partners, culminating in a high-profile, public commitment to collaborate as co-equal cluster members. The selection processes differed for the selection of priority sectors, industry partners, lead or anchor HEI, and additional HEI associate members. However, in each case the process was data-driven, was transparent, and adhered to a principle of inclusiveness for HEIs that sought to improve quality. From the beginning, addressing industry needs was the driving force or purpose for the formation of the clusters.

Figure 4. Phase One: Forming clusters



Step 1: Selection of dynamic economic sectors and industry champions

The starting point was to identify high-growth and dynamic economic sectors and pick a select number to focus on for creating industry–higher education clusters. The project conducted a two-step process based on (1) economic criteria, using traditional economic analysis methods to selecting priority sectors; and (2) industry criteria, using an innovative approach developed by the project to gauge which industries would be most willing to commit to achieving the objectives of the industry–higher education collaboration model and contribute time and resources.

Table 1 outlines the specific economic criteria used to conduct the first part of the analysis.

Table 1. Economic criteria for industry sector selection

Economic Criteria To identify sectors that have the potential to contribute to economic growth.
1. **Employment expectations:** Rate of employment growth and expansion plan for the sector indicating clear understanding of career profiles needed.
2. **Exports:** Potential for exports based on the market diversification and/or sustained growth in exports.
3. **Growth projections:** Projected growth in production or expansion in the sector and contribution to gross domestic product.
4. **Government prioritization:** Sector priority based on the GOES 2014 Productive Promotion and Diversification Policy.
5. **Competitiveness:** As measured by productive capacity and market appeal through a strategic directional matrix. The matrix tool combined the internal variables of the country with the external opportunities in global markets, to determine industries with both growth capacity and regional and international competitiveness.
6. **Input-output matrix:** The industries' position in the input-output matrix of the Central Bank's macroeconomic accounts in 2010 (i.e., the latest available at the time).

The economic analysis identified sectors with the greatest potential for growth based on past and projected growth; the largest employers; the most competitiveness in export markets; a strong competitive position based on national and regional markets; and those already selected as specific priority sectors for the country by the GOES (through its 2014 Productive Promotion and Diversification Policy). In addition to analysis of the national and international economic data, researchers interviewed industry associations and other private sector representatives to incorporate firsthand industry feedback into which sectors were most dynamic and poised for growth.

At the end of this first phase of research and consultations with industry, the results of the economic analysis identified and ranked 10 economic sectors with the highest potential to contribute to economic growth:

1. ICT,
2. energy and energy efficiency,
3. light manufacturing,
4. health products and services,
5. agroindustry and food processing,
6. aquaculture and marine coast products,
7. advanced logistics,
8. recycling and environmental services,
9. international services, and
10. construction.

These 10 sectors represented 35 industries or branches of economic activity. This prioritization was based on the analysis of more than 290 subsectors.

The results of the economic analysis were presented at high-level meetings with all the key industry and private sector groups in the country in attendance, such as the El Salvador Chamber of Commerce, the American Chamber of Commerce, and the Ministry of Economy. There was consensus that these were the appropriate sectors on which to focus, and key business leaders overwhelmingly endorsed the sector selection results, giving credibility to the process and building private sector buy-in to the approach.

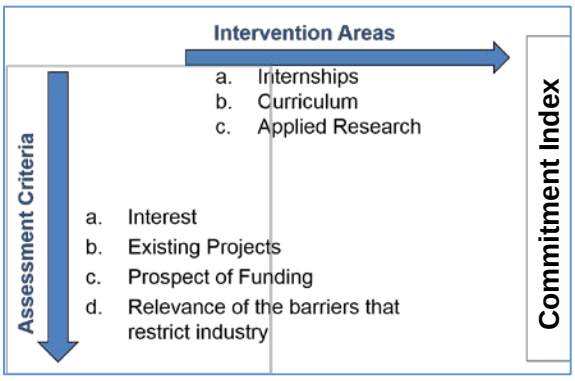
The next step in the industry selection process was to pick industry champions from among these 10 potential sectors based on commitment criteria. ***Table 2*** outlines the specific commitment criteria used to conduct the second part of the analysis.

Table 2. Commitment criteria for industry sector selection

Commitment Criteria Based on the outcome of the economic criteria, discussions were held with each sector.
1. **Internships/externships:** Interest and commitment to participate in internship and externship programs.
2. **Applied research:** Degree of willingness to provide resources, both human and financial, to applied collaborative research initiatives.
3. **Advisory boards:** Willingness to commit human resources to work on the Industry Advisory Boards (IABs) and to design curricula.
4. **Strategic information:** Willingness to share strategic information about the sector to guide the curriculum development process.
5. **Business champion:** Participation of business associations or lead businesses of the sector.

The objective of this phase of the process was to measure the interest and willingness of industry leaders to collaborate with HEIs on improving their competitive potential through joint investments in talent and research. One of the challenges was in obtaining up-front commitments from private sector partners, short of requiring specific financial contributions as a condition for becoming a formal partner. The project was concerned that asking for too much of a financial commitment would dissuade potential private sector partners. Based on anecdotal experiences, the project's leaders knew that private sector resources would follow once the project could demonstrate some early results of industry–higher education collaboration and private sector leaders had evidence of the potential return on investment. Hence, a structured approach was developed to gauge industry support through alternative examples of commitment. ***Figure 5*** illustrates the model used to analyze potential industry commitment.

Figure 5. Analysis model for potential industry commitment



The project developed a "commitment index" along two dimensions. The index's first dimension was expressed willingness among industry groups to participate in some of the project's key areas of activities: (1) curriculum reform and advisory role in IABs; (2) internships (faculty externships and student internships); and (3) applied research. The second dimension included an analysis on the following factors: (1) industry interest (willingness to participate in project key activities); (2) existing projects/collaboration with HEIs (evidence demonstrating joint work with HEIs); (3) prospect of funding;

and (4) relevance of barriers that restricted the industry and the ability of the project to address these barriers before its ending.

The researchers interviewed the main industry associations and representative business groups for each of the 10 sectors to get information along the various categories outlined above. The researchers then systematized the qualitative information from these interviews and scored the information based on a defined scoring system. An evaluation matrix permitted a triple analysis for the three key areas of project activities. In other words, each sector was scored on the four categories of analysis for each of the three project activity areas.

The data-driven and transparent approach to selecting industry partners was important, because there was significant private sector interest in becoming involved with this project. Thus, the decision making behind which sectors and industry partners the project would focus on needed to be backed by objective rationale that both selected and non-selected industries could support. The approach instilled credibility in the process and resulted in buy-in from the private sector. It also allowed the project to gauge and measure industry's potential "skin in the game" without asking for cash contributions too early in the relationship-building process.

This process resulted in selecting four high-priority economic sectors for the formation of the industry–higher education cluster: (1) ICT, (2) energy and energy efficiency, (3) light manufacturing, and (4) agroindustry and food processing. Industry partners, the main industry associations representing each sector, are summarized in ***Table 3.***

Table 3. Industry partners

Sector	Industry partner	Description
ICT	Salvadoran Chamber of Information and Communication Technologies (*Cámara Salvadoreña de Tecnologías de la Información y Comunicaciones,* casaTIC)	Founded in 2010, casaTIC had more than 50 members in 2017 and is an important reference in the ICT sector in El Salvador. casaTIC is also part of the Board of Directors of the World Information Technology and Services Alliance.
Light manufacturing	Salvadoran Association of Industrialists (*Asociación Salvadoreña de Industriales,* ASI)	ASI is the leading industry association in the country, representing 23 industrial and agroindustrial sectors and over 380 businesses. The industry sectors ASI represents produce 92 percent of the country's exports, generate 40 percent of formal employment, and contribute to 24 percent of the economy's gross domestic product.
Energy and energy efficiency	Salvadoran Renewable Energy Association (*Asociación Salvadoreña de Energías Renovables,* ASER) and ASI	Founded in 2012, one of ASER's main objectives is to lead the development of and investment in the generation of energy from renewable resources and boost the competitiveness of companies in this sector. It brings together members with different renewable energy technologies that are under development. See above for ASI description.
Agroindustry and food processing	Agricultural and Agroindustrial Chamber of El Salvador (*Cámara Agropecuaria y Agroindustrial de El Salvador,* CAMAGRO)	CAMAGRO's vision is to be the leading and integrating association that generates the conditions of a strong, competitive, and successful agricultural and agroindustrial sector.

Step 2: Selection of HEI leaders for each cluster ("anchor HEIs")

Recognizing that no one HEI contained all the resources needed to meet industry requirements, the industry–higher education clusters engaged multiple HEIs to collaborate in responding to industry. Furthermore, one university in each cluster was selected to serve as the leader, or the "anchor HEI." Each HEI organized action across the higher education community for its respective cluster. HEIs also could serve as associate members in more than one cluster, but could serve as the anchor of only one cluster.

As indicated earlier, the selection process for identifying HEI partners was based on principles of transparency, objectivity, and rigor using data-driven decision making. The selection process design placed strong emphasis on choosing HEIs that demonstrated a high level of commitment to partnering, and identifying HEI partners that were open to reform, were positioned to capitalize on the assistance provided through project resources with investments of their own, and were ready to fully commit to the shared objectives of the project. Another guiding principle in the selection of HEIs was involvement of industry partners in the decision-making process, allowing the private sector to have a consultative and active role in determining which HEIs were most prepared to meet the needs of each of the respective industry sectors.

The selection process began with a call for expressions of interest from HEIs to serve as an anchor HEI in each cluster. The project director met with the leadership of each of the HEIs expressing interest; the visits served to build relationships with the HEIs and to share the commitment required to serve as the anchor HEI. The project then disseminated the commitment criteria (see ***Table 4***) to HEI leaders in writing, and in turn requested a letter from the HEIs detailing how their commitments in this leadership role would be fulfilled. In addition, the project created institutional profiles of interested HEIs to analyze which universities had a significant number of educational programs relevant to the respective economic cluster (e.g., information technology majors and STEM majors).

Table 4. Illustrative three-tiered commitment criteria to serve as anchor HEI

First-tier commitment
• Hire or appoint a dedicated cluster director. • Provide incentives for faculty to participate in academic and professional development training, including professional science master's degree programs and training in 21st century pedagogy, high-demand fields, English, and other opportunities. • Support faculty to participate in faculty externships to get first-hand exposure to latest state of practice in industry. • Establish a career development center, a dedicated campus office, or space for physical location of career center; hire career development center manager/director; and hire one or more career guidance counselors.
Second-tier commitment
• Appoint faculty members responsible for curriculum planning of existing or new careers specific to the cluster. • Provide in-kind commitments, including use of campus facilities (classrooms, conference rooms, and equipment) for faculty training activities; and use of equipment and materials for hands-on student training and faculty applied research projects (laboratories, equipment, and materials).

Third-tier commitment
• Participate in assessment of human and institutional capacity. • Appoint one high-level representative to participate in the higher education policy dialogue process. • Participate in an annual strategic planning meeting with other anchor HEIs of other clusters. These meetings were scheduled in the cluster annual work plans.

Industry partners, together with the project's senior leadership, made the final selections of the anchor HEIs based on analysis of the institutional profiles and an evaluation of the commitment criteria. In some cases, the ranking of the institutional profiles and commitment criteria was insufficient for deciding, requiring follow-on negotiations with industry and the project's senior leadership. In one instance, an HEI ranked highest for two different clusters, manufacturing and energy. After a visit with the project director, however, the HEI's leaders decided not to anchor in the field in which they were strongest (energy), but instead to focus their investments in the area in which they aspired to become stronger (manufacturing). This showed that HEIs were willing to take risks and make investments to grow their academic offerings in new disciplines, and that HEIs trusted that their leadership in industry–higher education clusters would yield returns for their educational institutions, industry, and the country. It is also a testimonial to the trust that had been established in the model of change and the transparency of the selection process.

Step 3: Formation of broad alliances among HEIs ("associate HEIs")

The clusters emphasized inclusivity as an important aspect of the model, giving all HEIs an opportunity to participate as "associate HEI" members if they were unable to apply for or uninterested in serving as an anchor institution. This model of collaboration across multiple HEIs helped to strengthen social capital across the higher education sector. HEIs participating as associate members benefit from cluster activities in faculty training, curriculum upgrading, and applied research. As part of the cluster, they also benefit from learning and knowledge sharing that occurs between the lead anchor and associate HEIs.

Associate HEIs were institutions that demonstrated some capacity for research and training and were committed to work collaboratively with other HEIs. Among the 40 HEIs in El Salvador, none alone represented all the capacity needed to meet the needs of industries in each cluster for talent and research. However, by working together, they could pool their resources and capabilities to better meet industry needs. This approach required a shift in mindset away from competition and moving toward collaboration, thus creating an alliance of HEIs to achieve synergies to serve the common good of the sector and of the country's higher education system.

It is important to note that the one national university, University of El Salvador (UES), opted to join all the industry–higher education clusters as an associate member and committed to be part of the collaborative effort to improve the higher education system. This commitment was a critical partnership for the clusters, as UES is an important Salvadoran HEI, with more than 30 percent of student enrollment in higher education and more than 50 percent of R&D expenditure in higher education. Through this strategic partnership, UES, the only public university in the country, committed to making its facilities and research laboratories available to researchers from other HEIs for applied research projects relevant to industry needs, an unprecedented act of professional cooperation.

Crossing boundaries, building trust, and investing in cooperative initiatives was a theme that ran throughout the formation and operationalization of the clusters. Achieving system-wide change in higher education requires collaboration across all players. Curriculum reform is a good example of this. The ICT cluster was the first to begin curriculum reforms at a sector level, involving six HEIs working together and with industry partners to develop a common IT curriculum across all participating HEIs. The curriculum eventually will include different specializations at each HEI in which students will be able to cross-enroll. When the IT faculty first met to launch the initiative, they acknowledged that it was the first time they had met together across institutions. More examples of cooperation are presented in Part 4.

Step 4: Bringing industry and higher education together and launching clusters

By the end of the project's first 15 months, four clusters had been established with 11 of the 40 HEIs in El Salvador as HEI associates.[2] Together, the four clusters brought together an impressive web of actors, linking more than 400 member companies that were producing two-thirds of the country's gross domestic product, with 12 HEIs that enrolled approximately 91 percent of STEM higher education students in the country (Ministerio de Educación, 2016, pp. 20–21).

The culmination of Phase One was the high-profile, public commitment of industry and HEIs to collaborate in forming the four clusters. In a post-conflict country such as El Salvador, this act was highly symbolic of reconciliation and a commitment to reestablish trust between the private sector, which had been aligned with the political right; and the academic sector, which was characterized as aligning with the left. After almost 25 years, the two sides came together for the first time for the betterment of the country. It is perhaps for this reason that the launch of each of the clusters was a major public event. For instance, the U.S. Ambassador participated in three launch events and senior Salvadoran government officials participated in all four alongside industry and higher education leaders. The launch of the manufacturing cluster was organized in parallel with an innovation summit to generate dialogue among industry, higher education, and government on innovation and research collaboration together. The "buzz" created by high-level dignitaries enhanced the enthusiasm and interest in participating in the clusters.

As previously mentioned in this paper, the industry–higher education cluster model was new to El Salvador. A key lesson learned was that the formation of clusters required a significant investment of time to bring together different sectors that traditionally did not work with each other. While the team found that private sector associations and HEIs showed initial enthusiasm in working with the project's model of change, they learned that it would take time to work out the details of the cluster partnership on roles, responsibilities, and terms of partnership.

As a demand-driven economic growth model, it was important to be responsive to the pace and direction of the private sector and higher education partners to build buy-in and form strong working relationships. The project team needed to be mindful of the internal decision-making structures and timing of industry partners, particularly for industry associations (*gremiales*) that had to explain the partnership model and commitment levels to their boards of directors and association members (private-

[2] The process for selecting associate HEIs remained open and new members later joined each of the four clusters.

sector businesses), and HEI partners that also had their own internal decision-making structures through which they needed to work.

Phase Two: Operationalizing the Clusters

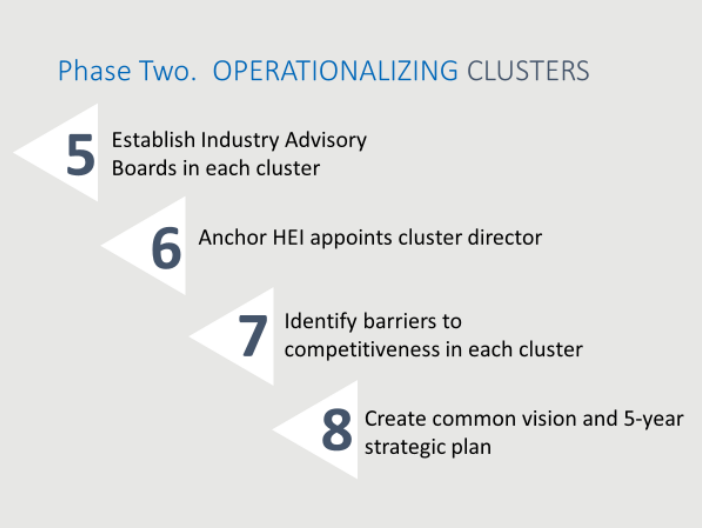
Phase Two of the cluster formation model involved establishing the organizational structure in which decisions for investment would (1) be industry demand-driven; (2) be data-driven; (3) be transparent; (4) drive quality improvement; and (5) include all relevant and willing stakeholders. Each cluster required

- an active IAB, with representation from industry, HEIs, and GOES;
- an IAB coordinator, a private-sector executive elected by all IAB members;
- a cluster director, a full-time faculty member supported by the anchor HEI and responsible for driving change, commitment, and cooperation among cluster members; and, in some cases,
- cluster working groups, responsible for implementing specific activities outlined in the cluster strategic plans and work plans.

Through dialogue facilitated by participation in their various structures, cluster members achieved a holistic, demand-driven perspective, where the IABs advised and provided strategic vision, the cluster directors synthesized strategy and implementation, and the working groups implemented and executed. Dialogue became the critical element for the cluster to see itself as an integrated system.

Figure 6 illustrates the steps in Phase Two that were necessary for the clusters to become operational and sustainable. While these steps are presented in a linear fashion in this paper, in practice, many happened in parallel.

Figure 6. Phase Two: Operationalizing clusters



Step 5: Establish IAB for each cluster

The project has facilitated the creation of El Salvador's first-ever IABs in higher education and industry.[3] Before, Salvadoran universities lacked liaisons who focused on understanding industry needs, building relationships with private sector, and coordinating educational planning with industry representatives. The development of IABs was a big step forward in helping universities and industry begin to actively step into each other's worlds to regularly communicate and jointly plan how to better align education with industry.

Together with leadership from Salvadoran industry and HEIs in each respective cluster, the project has been working to adapt and contextualize the IAB model used in the United States to fit the realities of El Salvador and meet the needs of each distinctive cluster. One important difference between the U.S. community college IAB model and the Salvadoran IAB is that the latter will advise all HEIs that are members of the cluster—as opposed to just one HEI—thereby expanding the IAB's impact. For example, in the area of curriculum, the IAB in each cluster identifies the competencies needed in its respective fields. In some cases, the IAB may also identify training programs that certify the acquisition of the required competencies. The HEI members of the clusters collaborate in faculty professional development and the launching of new certificate programs and other curricular reforms to respond to industry demands. Examples of industry impact emerged in the changing curricula in the IT and the energy and energy efficiency clusters.

Across the various clusters, the IAB membership is formed with industry associations, high-level industry representatives and business professionals, HEI officials (a mix of presidents and curriculum coordinators), and representatives of government agencies, such as the Salvadoran export and investment promotion agency (PROESA), which is actively involved in two IABs. The IABs are largely private-sector driven with strong leadership from the industry and business representatives.

Lessons learned from the early experience with the IABs across the different clusters include the following.

- **Designate an IAB coordinator.** Appointing a dedicated IAB coordinator is critical to the functioning of the IAB. The IAB coordinator is a private sector executive who is elected by IAB members and who is a well-known and respected leader in the private sector. This leader helps to bring others on board to join the IAB, and this individual's networks and reputation lend credibility to the IAB. Most importantly, the coordinator understands the importance of creating "shared value," which Porter and Kramer (2011) defined as "generating economic value in a way that also produces value for society by addressing its challenges" (p. 62). Therefore, the coordinator does more than chair the IAB meetings. She/he is responsible for driving change and ensuring ongoing commitment and cooperation among the private sector members of the IAB (i.e., a "collaboration champion"). The role of the IAB coordinator is an unpaid position, which

[3] IABs are common bodies in the U.S. community college system and in industry sector partnerships in the United States. Typically, they bring together industry representatives and employers at an educational institution to serve as an advisory and planning partner in helping colleges stay current with industry trends, employer hiring practices, and skills needs for entry-level talent. IABs can help guide decision making at HEIs in curriculum changes, educational degree programs, internship programs, and student career services, among other areas.

requires a commitment of time and understanding that the role is not to represent a particular business, but rather the sector as a whole; as such, an understanding of sector-level needs is paramount.

In the case of the ICT cluster in El Salvador, the IAB coordinator was the head of an international IT company, was a Salvadoran, and possessed a track record of civic and industry leadership. Her network of other like-minded executives willing to commit their time to address a common need for more high-quality local talent to the industry was key. She decided that the first IAB meetings would be held exclusively with industry members to engage in a dialogue to develop a common understanding of the challenges they faced in the sector and how industry–higher education clusters could contribute to improving their competitiveness and potential for growth. Next, the HEIs were invited to make individual presentations on their IT academic programs, faculty, and research, after which the IT executives acknowledged their misconceptions of the HEIs and recognized the value in collaborating. Once the HEI representatives sat at the same table with the industry executives, they too admitted to misperceptions of the private sector, but rather than hearing from industry leaders, they visited industry workplaces. In one visit to the Avianca Airlines IT department, with over 1,000 employees, the university presidents and deans were welcomed by alumni working at the company, and they were shocked by the differences in the way the industry worked compared to the way their students were being taught. While the takeaway was different for each higher education leader, all committed to updating their curricula and teaching methods to more closely support the way their graduates would work in the future.

- **Enlist experienced international advisors.** As part of helping to establish the first-ever IABs in El Salvador, RTI enlisted international expert consultants to work directly with the early members of the IABs in the ICT and energy sectors. Consultants from community colleges in the United States shared firsthand testimonials of how IABs work to advise community colleges and help keep their curriculum demand-driven to local industry. They also shared best practices on how to make IABs effective. For example, they advised that IABs should ask the HEIs to devote at least 50 percent of their joint time to listen to the issues, concerns, ideas, industry trends, and hiring needs of private sector colleagues. Many Salvadoran companies shared that it was very helpful to have a firsthand example of how IABs work and to hear success stories as motivation that this type of close industry–HEI collaboration is possible.

- **Direct the IAB toward advising.** The IAB is more effective in a strategic and advisory capacity guiding higher education–industry decision making, rather than serving as an operational body. It does not get into the details of educational planning.

- **Assemble the IAB separately at first.** Convening private sector members of the IAB first helped to create cohesion and identity as a group, created a space for open and honest dialogue among peers in their industry, and allowed the IAB private sector members to identify what they wanted to get out of their collaboration with their HEI counterparts before meeting with them.

- **Allow time for introductions and trust-building.** The first meetings between industry and HEIs tend to focus more on “getting to know you” and beginning to lay the foundations of

communications and trust. As in personal relations, trust-building starts with mutual acquaintance and sharing of experiences.

- **Explain academic curricula to industry.** Industry typically has the perception that universities do not have academic programs relevant to industry needs, and they often complain that graduates are not well prepared for the workforce. Part of the problem is that companies are simply not aware of or exposed to the breadth of academic programs at the educational institutions. We found that it was effective to use IAB meetings as a space for industry representatives to meet with curriculum planners from multiple HEIs in the cluster, who could present information on current academic programs and curriculum content, such as ICT-relevant programs in computer science, digital animation, information systems, and telecommunications. Industry members left that meeting surprised with the degree of ICT-related curriculum at their universities that they previously were not aware of.

- **Reach consensus on operating principles.** For the IAB to be an efficient body with longevity, it is important for the industry and HEI members to co-define and establish the body's operational guidelines. For example, they must establish the group's decision-making processes, decide on the frequency of meetings, develop meeting agendas with clear objectives, develop rules for IAB membership, and set up the governance structure. One of the project's international partners—Corporation for a Skilled Workforce, which has supported many IABs in the United States—helped develop an IAB toolkit that provides resources, planning tools, and templates to guide the newly formed IAB groups.

Step 6: Appoint a dedicated cluster director

The industry–higher education cluster model requires a dedicated (full-time) management structure to effectively implement cross-sector collaboration and oversee the complex relationships among HEIs, industry associations, and private sector companies. Each cluster is managed by a cluster director, who is appointed and financed by the anchor HEI for each cluster, which ensures a model of sustainability and local ownership.

Ideally, the cluster director is a senior member of the anchor HEI faculty, has the confidence of the institutional leadership, and has an established track record of research in collaboration with industry and in mentoring students who are well placed in industries. The profile of an ideal cluster director is not necessarily that of a successful academic by traditional academic standards. The entrepreneurial faculty member is often the outlier among his or her colleagues, and is highly valued by the industries represented in the cluster. ***Table 5*** outlines the characteristics of a successful cluster director.

Table 5. Characteristics of a successful cluster director

- Is recognized as a leader in higher education and discipline relevant to cluster (e.g., energy)
- Is respected by industry peers
- Has strong relationships with industry
- Demonstrates excellent leadership ability
- Takes initiative

- Has strong communication and facilitation skills
- Listens well

The industry–higher education cluster also demands that the cluster director represent the whole cluster and not just the anchor HEI, even though their compensation and academic home are determined by the institution. Nevertheless, because multiple institutions are cooperating in the cluster, the director must become very familiar with the human and physical resources of the associate HEI members as well. In other words, collegiality must extend beyond institutional boundaries to include all cluster members.

Step 7: Identify barriers to cluster competitiveness

Before developing a strategy to enhance cluster competitiveness, each of El Salvador's industry–higher education clusters commissioned a cluster competitiveness profile to identify and analyze barriers to cluster competitiveness.

These cluster profiles analyzed the recent performance of each of the four sectors explained in Table 3 above—(1) ICT, (2) energy and energy efficiency, (3) light manufacturing, and (4) agroindustry and food processing—and identified current trends and growth drivers for a clearer understanding of barriers that were inhibiting growth and productivity, areas of comparative advantage, and opportunities to enhance competitiveness. Specifically, the cluster profiles analyzed the following elements:

- core industry and secondary subsectors;
- principal products and services;
- local and international markets;
- productivity trends;
- in-demand human capital and skills requirements;
- current academic and technical programs in higher education; and
- R&D barriers and opportunities.

The researchers conducted an economic analysis and key informant interviews with leaders in industry, academia, and government. They also used the "SWOT" analysis framework to identify overall **s**trengths, **w**eaknesses, **o**pportunities and **t**hreats for each cluster. ***Table 6*** presents some of the key findings from the cluster competitiveness analysis.

Table 6. Key obstacles and opportunities to help the sector become competitive

Cluster	Competitiveness barriers and opportunities
ICT	• The digital revolution provides new opportunities for developing countries to link to global markets. A critical success factor for competing in the global environment in the ICT services sector is to have a skilled, productive, and certified workforce. • Hard-to-fill occupations and occupations that are growing in the sector include business intelligence specialists, programmers and software developers, project managers, systems analysts, cybersecurity specialists, video-game developers and digital animators, middleware specialists, big data and agile methodologies specialists, and cloud-computing specialists. • IT entrepreneurs and managers stated that the following specializations are needed in the sector to overcome talent shortages: IT security or cybersecurity; data center management

Cluster	Competitiveness barriers and opportunities
	and business intelligence specializations; IT architecture; and software engineering. In-demand IT skills are virtualization, .NET, PHP, and Sharepoint. • Emerging IT technologies that show potential for investment and growth include mobile applications, cloud computing, middleware, big data, IT security, Internet of Things, and robotics. • There is potential for IT to provide crosscutting technological solutions to various productive sectors and to apply technologies to address national problems in security, health, education, energy, and natural resource management.
Energy and energy efficiency	• There is a need to strengthen infrastructure, which includes areas of specialization such as smart grid, power transmission and distribution, and energy quality in production processes. • It is important to promote the use of and strengthen the knowledge of new energy-generation technologies—which encompass energy storage systems, renewable energy, autogeneration for self-consumption, biofuels, biomass, photovoltaics, wind, hydroelectric, and natural gas, among others. • More investment is needed in energy management, which takes into account energy efficiency within production processes, energy efficient buildings, construction and transportation systems, and emerging energy-efficient technologies. • Increased focus on assessing energy impact on climate change is necessary, which includes human capital knowledge needs regarding the global carbon footprint and the efficient use of water resources, among others.
Light manufacturing	• To build a competitive industrial sector, a new range of products and industrial services needs to be developed by following a process of innovation and by undertaking applied research. • New curricula are needed that are based on applying international models, strengthening standardized STEM skills at the early stages of careers, and reinforcing skills by subsector and crosscutting areas. • Theoretical and practical learning for students should be ensured through internships and research programs. • A critical need exists for industry-efficient technological solutions and skilled employees' knowledge on flexible production, quality management, supply and demand management, research on operations and processes, and sustainable manufacturing. • New products and advanced materials are strategic areas that will improve domestic and international competitiveness.
Agroindustry and food processing	• Increasing competitiveness in this sector requires modernizing agricultural production and creating more opportunities for value-added processes and products along the agricultural production chain through use of technology, efficiency in processes, cost reduction, quality management, and greater industrialization of agricultural raw materials. The process of industrialization of value added will require skilled and educated human capital with a new generation of technicians and professionals. • In-demand skills and occupations that are required for the sector to become more competitive include the following: quality management (Good Agricultural Practices [GAP]), Good Manufacturing Practices (GMP), Hazard Analysis Critical Control Point (HACCP), traceability); technicians and engineers with the practical knowledge to apply technological solutions in the agri-food industry; international trade, market intelligence, international regulations; R&D and innovation; laboratories; environmental management, sustainability, biosafety, and energy efficiency; specialized veterinary doctors, zoo technicians, and phytopathologists; and installation and maintenance of specialized machinery and equipment. • There are limited government resources for applied research programs, widening gaps in knowledge and technologies, and deterioration of research capacities in the industry. On the other hand, with availability of new research resources, industry leaders see the following R&D topics of high significance: (1) research on crop varieties with higher strength and performance, (2) adoption of new technologies (machinery, equipment, ICT), (3) development of new products, and (4) sustainable production processes and biosafety.

Step 8: Collaboratively develop common vision through cluster strategic plans

A competitiveness strategic plan can help move a cluster forward toward enhanced competitiveness and sustained growth. Strategic plans represent a vision for how firms and educational institutions might collaborate across industry and education to achieve growth. They also present a proactive road map for how firms can work with other firms and universities with their other academic peers, rather than seeing one another simply as competitors.

The project team learned that when a competitiveness strategy is being designed, it is very important to involve stakeholders at all levels of the cluster in a participatory manner so that all perspectives are incorporated and so that different actors in industry, higher education, and government feel a sense of ownership over the vision and the strategy. Along these lines, members of the ICT, energy and energy efficiency, and light manufacturing clusters underwent two-day strategic planning workshops. During the first day, the participants reviewed the previously prepared cluster competitiveness profile, which identified obstacles such as gaps in skills due to the lack of understanding of industry requirements, outdated curricula, and the need for applied research in various sectors. Members of each cluster discussed their visions for how to strengthen the competitiveness of their respective sectors, how to improve the position of the industry in the regional or global context if relevant, and how to develop the talent pipeline needed to take the industry forward.

On the second day, members developed strategic initiatives to overcome barriers and increase industry competitiveness. ***Table 7*** shows the results of these deliberations and the key elements that cluster members collaboratively identified for strategic investments to enhance cluster competitiveness.

Table 7. Key elements of cluster strategic plans

Cluster	Strategic lines
ICT	• Curriculum development • R&D • Market and business development • Communication, sustainability, and governance • Quality
Energy and energy efficiency	• Promotion, development, and integration of efficient generation technologies • Strengthening and modernization of transmission and distribution of electricity • Efficient management of energy • Relationship between generation and use of energy with environment and climate change • Electric market
Light manufacturing & agroindustry and food processing	• Curricula development and human capital • Research, development, and innovation • Quality and productivity culture • Communication, sustainability, and governance

Significant learning resulted from this new experience. Although most of the participants had already defined and worked with strategic plans in their respective companies or educational institutions,

no one had ever participated in strategic planning for an industry–higher education joint effort to strategize on how to make the sector as a whole competitive. One significant outcome from the joint planning session was that each cluster identified a strategy to sustain the cluster beyond the life of the project. Some important lessons learned from the experience included the following.

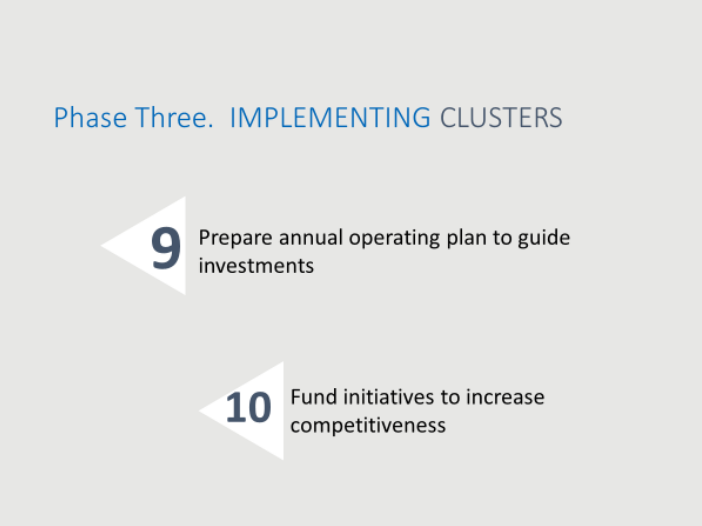
- **Research the barriers beforehand.** It was important to have first conducted the analysis to identify the barriers to cluster competitiveness, so that the cluster members could have an informed discussion based on data and trends that were driving or inhibiting overall competitiveness. The researchers who conducted the analysis presented high-level findings to the cluster members at the start of the strategic planning workshops to ensure that everyone began the process with a sector-level perspective.
- **Apply SWOT analysis methods.** Using the SWOT framework was helpful as it enabled cluster members to have a structured discussion about the cluster's strengths, weaknesses, opportunities, and threats.
- **Choose the facilitator carefully.** Having a skilled facilitator was important to keep the dialogue constructive and focused and to keep the participants attuned to reaching the workshop objectives.
- **Delegate some tasks to subgroups.** In the cases of the ICT and the energy and energy efficiency clusters, working groups made up of some IAB members, as well as other company and institutional representatives, were convened. The working group members then presented their proposed strategic plan to the full IAB in each cluster. In both cases, IAB members modified the working groups' suggested plans before adopting them for the clusters. The light-manufacturing IAB established subcommittees to work on different dimensions of the plan that were predetermined by the IAB coordinator and the cluster director together. As in the case of the working groups, the subcommittees each presented their results to the full IAB, which discussed, modified, and eventually adopted the five-year plan. The agroindustry and food processing IAB met in a plenary session to review the competitiveness profile and validate the results, before developing its strategic plan.

Phase Three: Ongoing Implementation

Phase Three of the cluster formation model is, as the saying goes, "where the rubber hits to road." As mentioned earlier, while the process is presented linearly in this paper, in practice, several activities have occurred simultaneously. For example, the absence of internationally recognized certifications in ICT, and an outdated curriculum in computer science and computer information systems, were identified early by the ICT cluster IAB as barriers to competitiveness. Therefore, the curriculum reform initiative began well before the strategic plan was completed and was integrated into the first-year operating plans. Similarly, the project launched an applied research seed-grant competition to complement intensive training in applied research, so that after completing the training, researchers could explore potential avenues for industry demand-driven research. In two clusters, light manufacturing and agroindustry and food processing, industry associations were already engaged in sector-wide initiatives to promote innovation and to identify barriers to competitiveness in value chains. In these cases, the respective IABs decided to support the continuation of the initiatives as a part of their first-year operating plans.

The examples cited above were driven by the realities on the ground in the implementation phase. Stakeholders came to the table with their priorities, as well as their current and ongoing commitments. According to Barnes et al. (2002), managing the inevitable cultural differences between industry and higher education is one of the major challenges to creating successful industry–higher education collaboration. In El Salvador, dialogue among stakeholders was necessary to manage the differences in expectations, and served to expose stakeholder priorities and commitments and to identify opportunities to harmonize them with the annual operating plans and funding priorities for each cluster ***(Figure 7).***

Figure 7. Cluster implementation



Step 9: Develop annual operation plans and implement activities

Based on the strategic priorities identified in the five-year strategic plan, each cluster developed an annual operating plan to focus activities and to guide investment priorities. In general, the operating plans in each cluster prioritized strategies for curriculum reform, development of internationally recognized certificate programs, establishment of faculty externships in companies related to their fields of expertise so that they would be able to bring real-world experiences into the classrooms, and industry demand-driven applied research.

However, not all activities involved industry–higher education cooperation. The anchor HEIs in particular had to commit internally to several initiatives to strengthen their capacity to respond to industry needs and to improve the management and operations of the institution. For instance, each anchor university agreed to establish a student career development center. While each HEI had services for students to varying degrees, none had comprehensive services to raise students' career awareness and prepare them to enter the workforce. The concept of career development centers was introduced to the HEIs to cover the full range of students' engagement with the university, from high school to alumni. The first level of engagement was to develop a pipeline of students entering the university through outreach programs, science camps after school and during school breaks, and communications campaigns. The second level has included helping students to choose the best majors for them and their career goals,

especially for those with an aptitude in STEM fields; and ensuring their success with academic counseling and student mentors. The third level of engagement has been preparing students to enter the workforce by providing internships in industry, workshops on building a resume and interviewing for jobs, and industry job fairs. The fourth level will be maintaining engagement after students graduate and enter the workforce, via establishing alumni organizations, having graduates return to the university as guest lecturers, hosting interns, and mentoring students.

Other HEI-focused activities included faculty training in English and 21st-century pedagogy, institutional strengthening (based on a needs assessment) focusing on an area identified by the institution as a priority, and a system-wide higher education policy dialogue in collaboration with the Ministry of Education. Finally, the project is assisting HEIs to develop matching scholarship funds to encourage and support students enrolling in STEM careers.

Step 10: Grant awards to clusters for implementation activities

The *Higher Education for Economic Growth* project includes a US$5 million grants program, with an additional US$5 million leverage requirement. A portion of the grants is earmarked to support curriculum reform, but the majority is to support industry demand-driven applied research. As mentioned earlier, a small seed-grants program was sponsored by the project to accompany faculty training workshops in applied research. The first major applied research grants competition coincided with the development of strategic plans. Research proposals required industry partners to respond to a need that had been identified in the cluster competitiveness profiles, aligned with strategic priorities, and involved more than one cluster HEI member. The IABs in each cluster reviewed and ranked proposals in their respective clusters. Projects that included more than one cluster were also encouraged.

This first round of competition was centrally organized by the project in collaboration with the cluster directors. Ideally, future competitions will be organized at the cluster level. Another goal of the grants competition was to identify projects that would have sector-wide impact. While projects that will benefit an industry or group of industries likely will also have benefits for improving competition, projects that transform a whole sector will most effectively demonstrate the value of the cluster as the engine of economic growth.

PART 4 – EARLY SUCCESS STORIES IN IMPLEMENTATION

While the industry–higher education clusters were still nascent as of early 2017, we could already see some examples of collaboration that would have sector-wide benefit. The following three examples stand out:

1. **ICT cluster:** Demonstrating the value of HEI collaboration within a cluster, six HEIs in the ICT cluster came together in an unprecedented way to revise their outdated IT curriculum in response to industry feedback. Instead of each university undertaking the process on its own, the HEIs coordinated to develop a core IT curriculum with four specializations[4] and agreed among themselves

[4] The four specializations were video game design and digital animation, software development, database management, and IT management and security.

which universities would deliver each of the specializations. Rafael Ibarra, former cluster director, said he believed *"the quality and specialization of human staff is a key differentiator in ICT industry and El Salvador can't continue graduating general professionals. This curricular reform is an important first step in that direction."*

2. **Energy and energy efficiency cluster:** The cluster model has facilitated the reformulation of social relations between the productive and academic sectors in the energy area. For example, Sherwin-Williams, a paint and coatings company that is at the vanguard of energy efficiency and has the only U.S. Green Building Council Gold-Certified building in El Salvador, invited industry and HEI leaders to tour its facility. The visit led to a full-day seminar for HEI deans and faculty on Leadership in Energy and Environmental Design (LEED) Lab, the education component of the U.S. Green Building Council, to prepare future professionals to integrate international standards of energy efficiency into new and existing buildings. Don Bosco University (UDB), the cluster's anchor HEI, afterward committed to establishing a LEED Lab at the university, which is requiring a substantial investment of university resources, major curriculum reform, and more than two years of faculty professional development. Sherwin-Williams is partnering with the university and has provided external consultants to help plan the project and build the capacity of faculty and administrators. The project will also support the integration of LEED Lab into eight engineering degrees at UDB, making the course part of the formal curriculum. In addition, HEIs in the cluster will have the opportunity to learn from and participate in the LEED Lab trainings delivered by UDB. The introduction of a LEED Lab in El Salvador ensures membership of the cluster HEIs in an elite international consortium of HEIs.

3. **Sustaining the partnerships:** At the end of 2016, a delegation of the project's key stakeholders, representing anchor universities, industry associations, and the Salvadoran government, visited Research Triangle Park, North Carolina, to dig deeper into how sustained partnerships transformed the state into a model of economic development, innovation, and growth. Building on this visit, the project's key stakeholders reaffirmed their commitment to the cluster model approach and more generally toward collaboration. The visit also underscored the need for and interest in a high-level steering committee composed of HEIs and industry across the four clusters, along with the participation of both the Ministry of Economy and the Ministry of Education. One of the key areas that the steering committee will prioritize is how to sustain the clusters in the long term. To that end, in 2017, RTI began providing technical assistance to develop a sustainability plan and process for the clusters, benchmarking against global best practice.

PART 5 – STRATEGIES FOR MANAGING INDUSTRY–HIGHER EDUCATION CLUSTERS

For countries looking to take a cluster approach to higher education and industry collaboration, we offer the following strategies and recommendations based on our experience in El Salvador.

1. **Treat aligning educational systems to respond to labor market needs as a complex systems problem, in which academia and the private sector often lack systemic vision to work**

collaboratively. The industry–higher education cluster model includes multiple actors coming together to address a collective problem that education, industry, or government cannot solve on their own. Initially, these multisector partnerships tend to come together through "first movers" who are early champions in each sector (a university president, a company's chief executive, a head of industry association, etc.). The early champions will convince their peers to show up at initial meetings, get involved in the collaboration, and open doors to people who need to be involved. Often the role of the intermediary, neutral matchmaker is important as a catalyst, a collaboration champion.

2. **Create a common vision that can unite the sectors and bring everyone to the same page, followed by a clear road map.** A common vision is necessary, but not sufficient. The cluster competitiveness profiles and the participatory strategic planning help to achieve a common framework to identify the problem and develop solutions. Actors can unite around a common framework and shared understanding. A road map or work plan that moves the group forward with clear direction, roles and responsibilities, time line, and actionable steps also is necessary. Working groups need to have clear goals, deadlines, and clearly defined responsibilities to keep everyone on track and motivated.

3. **Create quick wins early in the process to keep people engaged, and demonstrate in tangible terms what benefits the different actors are getting out of the collaboration.** For example, focus on short-term industry certification courses or training first, which can move at a faster pace, compared to reforming curricula and changing bachelor's degree programs, which can take two or more years to implement. Or, invite industry representatives to be speakers at training courses for faculty members to bring their industry knowledge up to date. Regularly monitoring progress and celebrating early successes are also necessary. When stakeholders see tangible results, it will create more demand, and they will want to engage. If stakeholders go to meetings that do not yield actions or results, they will drop off and the collaboration will fizzle out.

4. **Change agents (individual leaders) and formal bodies or structures help to institutionalize and sustain the industry–higher education clusters in the long-term**. **Clusters require organizational structure.** Each cluster in El Salvador has an active IAB, with representation from industry, HEIs, and the government; an IAB coordinator, who is a private sector executive elected by all IAB members to lead private sector partners; and a cluster director, who is a full-time faculty member supported by the anchor HEI and who is responsible for driving change, commitment, and cooperation among cluster members. In some cases, clusters convened working groups responsible for implementing specific activities outlined in the cluster strategic plans and work plans. Through their various structures, the clusters have achieved a holistic, demand-driven perspective, where the IABs advise and provide strategic vision. The cluster directors synthesize strategy and implementation, and the working groups implement and execute. While institutionalizing roles, processes, and structures is key for sustainability and clear organization, it is important to avoid becoming too rigid and tied to the structure but rather to stay flexible and continue to adapt to the changing conditions.

5. **Educators and businesspeople speak different languages and operate with different day-to-day business, needs, and challenges. To work together effectively, higher education and industry**

need to learn to speak each other's languages. One way to manage the inevitable culture gap is encouraging educators and industry leaders to step into each other's worlds by meeting frequently, visiting each other's work environments, and using common vocabulary. Meeting frequently to plan together and troubleshoot problems is important: Once-a-year, high-level meetings will not get the job done. It is important to understand that different actors have different agendas, perspectives, and constraints. A liaison such as a cluster director can help to translate the language that the different sectors use and can help business better understand how HEIs work (e.g., academic calendar, time lines, and the curriculum change process) and help educators understand how industry works (e.g., fast-changing technology, time frames, and processes for sourcing talent). Another example of stepping into each other's worlds involves faculty externships, which allow educators to work in industry when school is not in session, to get up to date on the latest industry practices and technology and to adapt their lessons plans and syllabi accordingly.

6. **Need to adopt long-term thinking and move away from "short-termism."** RTI's similar experiences from the United States and other countries, such as the Philippines, have indicated that it can take two to three years to establish clusters. It is important to set reasonable expectations with any donors or funders that are involved, and with the other various actors, so that people do not walk away prematurely out of frustration with the time line. Private sector representatives, for example, are prone to thinking in short time frames—such as what are their immediate hiring needs today—and not envisioning how to work with the education system to develop the future talent pipeline that they will need in 5 to 10 years. Looking forward requires long-term planning and resource investment.

7. **Showing "skin in the game": Educational institutions, industry, and government need to share the costs and co-finance the resources for industry–higher education partnerships**. While an intermediary, such as a donor, might initially sponsor a project or establish a pool of funding, long-term resources need to be raised to sustain the partnership beyond the initial period. In some cases, partners will be willing and able to contribute resources (e.g., cash, in-kind, or a combination of resources) early on, such as was the case with the HEIs and their commitment to hire and finance the cluster directors. In other cases, the contributions will be gradual or will come after some opening period of engagement. For example, some private sector partners will be hesitant to contribute financially before they see some early wins, but once they see concrete benefits, they will start to contribute resources. Regardless of timing, it is important to set the expectation that all partners are expected to show "skin in the game," with real commitment to resources. Both industry and HEI partners in El Salvador were selected based on commitment criteria and willingness to contribute sources to the collaboration.

8. **The industry–higher education clusters should clearly define what "success" of the collaboration will look like in three or five years (or whatever the time line is), and develop mechanisms and indicators for accountability to keep actors accountable to each other.** Success indicators should measure the results of the collaboration—for example, how the industry's satisfaction with the quality of skills and research being developed by HEIs changes over time. Another success measure could examine the sustainability of structures, such as the IABs, created within the cluster model: whether they last, or how they evolve beyond the support of donor funding.

CONCLUSION

We have argued that higher education is an essential partner to industry in improving competitiveness in today's knowledge- and innovation-driven economy. In many countries, and particularly in less-developed country contexts such as El Salvador, no single higher education institution is capable of meeting all the needs of industry. Therefore, we have introduced the concept of clustering HEIs with industry partners, alongside government, to work together closely to develop the future talent pipeline for growth sectors and reform education at the systems level. In El Salvador, the *Higher Education for Economic Growth* project has developed the model of industry–higher education clusters in four economic sectors selected for their potential for growth and commitment to collaboration: ICT, energy and energy efficiency, light manufacturing, and agroindustry and food processing. Each cluster includes an anchor HEI and other HEIs as associate members. Industries are represented on the IABs as the principal decision-making body for the cluster, with industry leaders chairing the IABs and serving as champions for industry–higher education collaboration.

Among the commitments to be the anchor university in a cluster is support for a full-time cluster director. The cluster director is essential for managing the activities of the cluster, beginning with a SWOT analysis or competitiveness profile for the industry, development of a five-year strategic plan, and preparation of an annual plan to prioritize cluster investments. The cluster director, together with the IAB chairperson, must be able to persuasively articulate the value proposition of the cluster model and to convincingly promote collaborative relations between industry and higher education, as well as cooperation between industries and between HEIs in the cluster. Development of a common vision is an essential characteristic of a successful cluster.

Establishing trust among the stakeholders is the first step in collaborative relations. By their nature, industries and HEI inhabit different realities and must be willing to step into each other's worlds and learn each other's language and interests. In a post-conflict society, such as El Salvador, establishing trust between two sectors historically on opposite sides of the conflict was particularly daunting. However, reaching agreement on a common and critical problem—stagnant economic growth—and identifying the strategic position of each sector to address the problem was the common ground to begin the dialogue. Stakeholders not only developed trust with each other but also adopted the model of change and acted on faith that implementation would be fair. Ensuring that decision making—from selecting priority sectors to prioritizing applied research projects—was industry demand-driven, transparent, and based on data, contributed to building trust and guaranteeing cooperation among the stakeholders. Industry and higher education leaders are learning that innovation is essential to remain competitive—together.

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