UNITEL M_ 4 _2

University-Business Collaboration: An Overview and Some Experiences

Responsible Partner: P8

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1. Learning Objectives

- **Objective 1:** Learners are provided with the cconceptual discussion of university -business collaboration
- **Objective 2:** Learners are provided with empirical findings of examination of the links between university-industry collaboration (UIC) predictors (inputs) and the results of UIC cooperation (outputs).
- **Objective 3:** Analyzing Examples of university-business collaborations related to Iran and selected foreign countries.
- **Objective 4:** Motivating the academic staff to acquire key competences and skills in order to learn business plan preparation, commercialization, entrepreneurship, etc.

2. Content of the Topic

2.1. The main content of the topic (4-6 themes):

- The course will involve the assessment of theoretical analysis on effects of main determinants on university-business collaboration.
- The course introduces key skills of business plans/policies for inclusion of pedagogical approaches in university curricula (some evidence).
- The course applies empirical method such as the partial least squares structural equation modelling (PLS-SEM), to explore the links between variables (To be done during the course).

2.2. Several Examples in Practice:

- Successful Collaboration between universities and Industries worldwide,
- Collaborations between international universities and Songdo International Business District (Songdo IBD),
- ECO Science Foundation (ECOSF) as a Catalyst for Science and Technology for Sustainable Development in the ECO (Economic Cooperation Organization) Region,
- Close Cooperation between Isfahan Universities and Isfahan Chamber of Commerce
- Isfahan Science and Technology Town and its collaboration with business (start-ups/accelerators/knowledge-based economic firms),
- A joint training program between University of Isfahan, Technical University of Munich and Mobarekeh Isfahan Steel Complex.

3. Theoretical Discussion on University -Business Relations:

3.1. Importance of Cooperation

- University–industry partnerships are not new phenomena globally and such relation is growing as companies and firms need to receive more knowledge, scientific findings, new technology and so on. They need to access empirical data and findings to be unique and survive in a competitive environment. Universities also need the data available in companies to conduct research. Universities and companies can also benefit from sharing their information, for example, they can exchange information in conferences and joint scientific meetings.
- Sharing equipment is also one of the other effective ways to communicate between the university and the industry. For example, a part of an academic project can be done in a company's laboratory and this project is focused on one of the challenges of that company in improving product quality.
- Universities are playing a critical actor in innovation systems of both developed and developing countries.

- In the context of developing countries, universities can play an important role as an indigenous knowledge source.
- Fruitful university-industry linkages (UILs) help local firms to import, modify, and diffuse technology.
- Universities can improve their academic capabilities if they interact with the private sector.

  Universities are the engine of innovation in both developed and developing countries. Universities can play a crucial role as an indigenous knowledge source in developing countries. Fruitful university-industry linkages (UILs) help local firms to import, modify, and diffuse technology especially if they interact with the private sector. Universities contribute to innovation in practice. Linkage between universities and companies can help be fruitful for diffusion of technology in industries.

3.2. What Does University–Industry Linkages (UILs) Mean?

- Studies and government reports have emphasized the importance of developing links between universities and industry. Although the purposes of such collaborations may be similar across higher education, the forms, extent, challenges, and risks are context specific.
- University–industry partnerships is defined as: ‘Trusting, committed and interactive relationships between university and industry entities enabling the diffusion of creativity, ideas, skills and people with the aim of creating mutual value over time’ (Plewa and Quester, 2008).

3.3. UILs have a number of key benefits and advantages:

A) UILs lead to:

- Development of new study programs (Forsyth et al., 2009; Plewa et al., 2015).
- Increase research productivity and enhanced opportunities for faculty and students to participate in research (Laursen et al., 2011; Turk-Bicakci and Brint, 2005).
- Advances in innovation and technology.
- Establish new funding streams for universities and enhancing student employability (Thune, 2011; Bernarte, 2014).
- Politically benefit institutions 'such as the enhancement of reputation or institutional prestige and responsiveness to government initiatives' (Prigge, 2005).
- Improve the quality and relevance of higher education.
- Enhance students' future employability.
- Improve the quality and relevance of the education provided. Collaboration with industry has been important for understanding recent market trends and integrating students' theoretical knowledge with practice.
- Career fairs, career advisement activities, apprenticeships, internships, recruitment programs, and investment or equipment loans.
- Faculty consultancies, employers serving on university advisory boards, and lifelong learning activities (Brandt et al., 2009). Such as continuing education courses, skills development for employees of companies, and development of training packages for specific organizations.

B) Most importantly, UILs help faculties gain access to:

- Scarce research resources, creating new opportunities for faculty research,
- Greater research productivity, and
- Increased academic publications (Harman, 2010).
- Research collaborations may involve joint research projects, the provision of funding by industry for specific university research
- The establishment of research parks and the leveraging of the research capacity of universities and industry
- A wider range of UILs' activities also include:

  developing new educational programs,

  mentoring,

  supervising students and

  skills and competency development.

C) Further Advantages

Collaboration with industry benefits students, faculty, education programs, research output, and university reputation overall. Engagement with industry informs faculty and senior leadership on labor market needs, allowing them to adjust the relevance and quality of education programs and further the strategic development of institutions. With access to industry, students gain work-relevant skills, develop entrepreneurialism, and create professional networks. Involvement of outside industry experts can improve the quality of faculty research, foster research area expertise, and provide important opportunities to test practical application of research findings. Most importantly, UILs help faculty gain access to scarce research resources, such as cutting-edge industrial laboratories and expensive materials, creating new opportunities for faculty research, greater research productivity, and increased academic publications.

- Partnerships can assist universities in cutting costs, particularly those related to students funding, faculty salaries, and research. Studies suggest that faculty who collaborate with industry receive conference support and are more satisfied with research equipment, PhD students, and the intellectual

environment of their department. Industry can also be an additional source of funding for students' scholarships, fellowships, cultural and athletic events, facilities, and equipment.

- UILs also provide adjunct faculty, faculty salary, research, and equipment for laboratories.
- UILs can have a positive impact on the profile and quality of programs and prestige of universities.
- Universities engage with industry in field-specific ways that primarily encompass in two areas: joint research activities and development of educational programs. Research collaborations may involve joint research projects, the provision of funding by industry for specific university research
- the establishment of research parks and the leveraging of the research capacity of universities and industry
- the provision of feedback on the practical relevance of university research.
- Educational collaborations include a wider range of activities, including developing new educational programs, revising existing programs, and involving employers in teaching, mentoring, supervising students and activities related to skills and competency development.

3.4. Challenges on University -Business Collaboration

- While the literature describes many benefits to UILs, it also points to complexities and risks.
- There are indeed practical difficulties, cultural differences between universities and industry, disputes over intellectual property rights, and conflicts of interest.
- There should be absence of incentives to encourage faculty participation in partnership initiatives (Siegel et al., 2003; Karlsson et al., 2007).
- In some universities, lack of expertise or skill in establishing and maintaining contacts with industries can hinder the development of collaborations (Basit et al., 2015).
- Scholars may face differing organizational cultures and environments, universities' unrealistic expectations, and HEI bureaucracy (Siegel et al., 2003).
- Other challenges to UILs involve conflicts of interest over research priorities; allocation of personnel, financial, and material resources; and communication and secrecy.
- Prigge (2005) argues that UIL risks for HEIs include a shift from basic research to applied research and product development, compromises in academic integrity, constraints on the open and timely dissemination of research results, narrowing of research topics, pre-empting research and teaching preparation time, and encouraging the migration of faculty to partner organizations.
- Industry-funded research can result in conflicts between UIL researchers as well as tensions between university departments (Harman, 1999).

4. Examples in Practice

4.1. Successful Collaboration Between Universities and Industries

- From 1995 to 2000, M.I.T. obtained over 100 patents per year. It means there is a close relation between two sides.
- In 1999, 20 % of M.I.T. research was funded by industry.
- In collaboration with industries, different licenses of patents were awarded to the universities: the Cohen-Boyer patent on recombinant DNA (Stanford University, University of California San Francisco), the Axel patent on gene expression (Columbia University), the patents on Warfarin and vitamin D (University of Wisconsin), the patent on the cis-platinum antitumor agent (Michigan State University), the Hemophilus vaccine patent (University of Rochester) and the Taxol synthesis patent (Florida State University).
- University licensing has led to the establishment of an impressive number of new companies.
- M.I.T. currently is setting up commercial licensing agreements at a rate of 80–100 per year with a total of about 600 active licenses. Of the new licenses granted by M.I.T each year, over 20 are new companies formed to develop the MIT-derived technology.
- Since 1987, more than 200 new companies have been founded. They are most successful when the inventors actively participate in the company, for instance, the professor acting on the Scientific Advisory Board; the students becoming employees and/or executives of the new company. In many cases, the new company with core technology will license its early products to various other companies with larger financial holdings (Demain, 2001).
- MIT plays a crucial role in improving the relationship between university and industry. This tables shows MIT's startup companies in different field are active and obtain good results and implications as a successful relationship between university and industry.

4.2. The International Food Safety Training Laboratory: A Partnership that Improves the Safety of Food Globally from September 2011 to Present

A) International relations:

- The International Food Safety Training Laboratory (IFSTL) is a partnership between the University of Maryland and the Waters Corporation.
- Signed in 2010, this alliance led to the creation of a training facility dedicated to analytical methods for food safety in microbiology and chemistry where subject matter experts from the U.S. FDA, USDA, EPA and academics from the University collaboratively deliver hands-on training (UIDP, 2014).
- This resource has benefited food laboratory professionals from many countries in its 18 months of operation and contributed significantly to the FDA's international capacity building plan aiming at strengthening laboratory capacity domestically and internationally to improve food safety globally. U.S. consumers have benefited since much of the food consumed in the U.S. is now imported and improving food safety in other countries benefits U.S. market.

B) Outcomes:

- Almost two years following opening, the IFSTL has made great achievements directly aligned to its mission. We have trained professionals from Guatemala, Peru, Mexico, the Dominican Republic, Honduras, Chile, Pakistan, China, Philippines, Indonesia, Malaysia and the United-States.
- Students from the University have been hired as teaching assistants, and a graduate student was hired as a full-time instructor.
- Feedback from the trainees indicates that the Laboratory contributes to improving laboratory capacity in food safety and also a better understanding of the regulatory framework in the United States, which helps develop food safety systems abroad.

4.3. Caltech Boeing Strategic Agreement 2004 – Present

- Caltech is a world-renowned educational institution with a long history of fulfilling the needs of industries, governments and academia. Boeing is the

world's leading aerospace company, providing products and services to over 150 countries (UIDP, 2014).

- In order to focus basic scientific research, Boeing has signed overarching, long-term research agreements with nine of the world's top research universities in specific critical technology areas.
- For Caltech, this is "systems integration" technology. Caltech provides world-class leading-edge research, technology and graduates, enabling the basis for advanced innovation leadership and allowing Boeing to benefit from a long-term relationship, access to the university research, as well as top students.

4.4. Songdo International Business District (SIBD) in Incheon, South Korea: A Modern Relationship between universities and business

A master-planned development within a free economic zone in Incheon, 40 miles (64 kilometers) outside Seoul.

- WSP-SIBD education sector experts have provided engineering and advisory services to hundreds of universities and colleges.
- WSP-SIBD delivers on all aspects of campus life: from parking garages, parks and landscapes, to specialized research laboratories and library facilities, to the student accommodation, lecture, and dining halls.
- WSP-SIBD services for post-secondary institutions include, structural engineering, buildings services engineering, lighting design, acoustics, sustainability consulting, and project management.
- Projects like the University of British Columbia's Library in Vancouver, the new campuses for Goethe University in Frankfurt, the Guildhall School of Music and Drama in London and the Manhattanville campus of Columbia University in New York demonstrate our ability to deliver expertise across the globe.

4.5. Economic Cooperation Organization Science Foundation (ECOSF): A Catalyst for Science, Technology & Innovation based Economic Development in the ECO Region

Economic Cooperation Organization (ECO) includes 10 members: Iran, Turkey, Pakistan, Afghanistan, Azerbaijan, Kazakhstan, Kyrgyzstan, Tajikistan, Turkmenistan, and Uzbekistan. One of agency of ECO is ECO Science Foundation (ECOSF) which concentrates on promoting research and technological development for achieving sustainable development and economic growth in ECO region. ECOSF pursues this goal through following key areas including: development of human recourse capacity for science, technology and innovation and science education in ECO region, strengthening institutional capacity in scientific research and technological development among its members, scientific technological resource collaboration among members and exchange of information on S&T development through workshops, conference and meetings.

A) Objectives of ECOSF:

- Development of Human Resource Capacity for science, technology and innovation as well as science education in the ECO region.
- Strengthening Institutional Capacity in scientific research and technological development among its members.
- Scientific, Technological and Research Collaboration and Cooperation among its member states and the developed world.
- Exchange/ dissemination of Information on Scientific and Technological Research and Development through workshops, conferences and meetings etc.

B) Programs in Practice:

The following table shows ECOSF's different programs for developing human resource capacity in science, technology and innovation (STI) sectors, including for instance, implementing the framework of Inquiry Based Science Education (IBSE).

Augment Human Resource Capacity Science, Technology and Innovation (STI) Sectors

Program	Key Milestones	Impact
Inquiry Based STEM Education	Trained over 1,000 Science Teachers in the ECO region – around 650 of Pakistani Teachers, 200 in Iran & 150 in other ECO Countries.	Enhanced interests in science subjects and learning outcomes – over 200 K students benefited
Capacity Building Program ECOSF Priority Areas – Climate Change, Energy, Water, Health and Food Security	Organized over 200 conferences, workshops and training programs. Provided training opportunities to over 2,000 S&T workforces in the ECO Region. Around 1470 of Pakistani workforce	Strengthened S&T workforce and enhanced capacity to address and contribute to the critical and emerging challenges of the ECO region.
Engineering Qualification Standardization, Accreditation and Professional System **(EQSAPS)**	Improved and developed Standards of Engineering Qualifications in the Central Asian states with help of UNESCO and Pakistan Engineering Council (PEC) in conformity with FEIAP and WA guidelines	Rallied mobility of Engineers of the Central Asian States with other ECO Member Countries.
Belt & Road **Science Education Program**	Enabled participation of the Students of the ECO region in Belt and Road (B&R) Teenager Maker Camps | CASTIC | Developed Science Curriculum based on Fusion of Civilizations	Expanded exchange, network and value-added capacity of young student in core scientific areas: AI, Machine Learning, Climate Change, & Food Security
BTBU-ECOSF Joint Training Center on Science, Technology and Innovation	Developed cross-industry and trans-disciplinary international training program to build essential human resource capital relating to infrastructural development among participating countries.	Trained Workforce in Critical Areas of Infrastructure Development, Special Economic Zones, Low Carbon Development and Electric Mobility

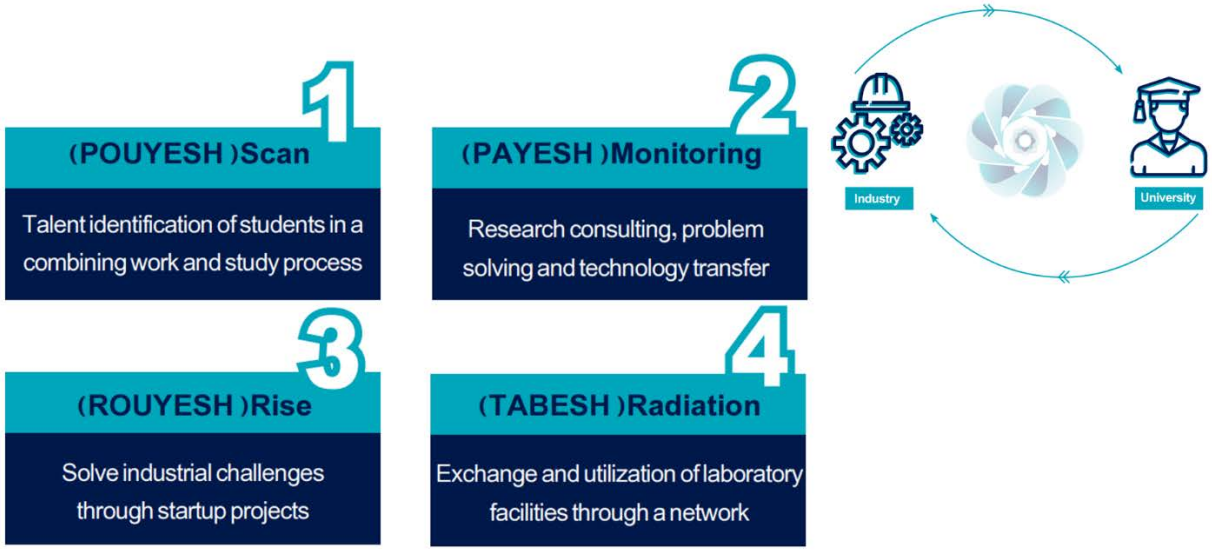
Economic Cooperation Organization Science Foundation (ECOSF)

4.6. Innovation Center of Isfahan Chamber of Commerce, Industries, Mines and Agriculture (ECCIMA) and University

The center of ECCIMA and University has been established implementing the following objectives:

- Running knowledge transfer in economic and business enterprises,
- Identifying and diagnosing the existing problems in industries, and
- Solving problems of the industries and business through conducting joint research between ECCIMA and the universities in Isfahan.
- Establishment and development of research and development (R&D) offices of economic enterprises in universities,
- Using the experiences of industry owners in universities and demand-driven academic activities and research,
- Compiling the educational content required by industry in the university are the main goals of this center.

A) Products of Innovation Center of ECCIMA & University



POUYESH (Scan)

Talent identification of students in a combining work and study process

- Easy and free evaluation and interview of job applicants
- Specialized training of the work force required by the economic enterprise along with the education
- Benefit from skill-based training courses for trainees with 80 % discount

PAYESH (Monitoring)

Research consulting, problem solving and technology transfer

- Providing free thematic consultations
- Design a process or product
- Reviewing and modifying organizational or productive structures or eliminating possible defects in equipment
- Production of products
- Participation in technology transfer and utilization of work force and equipment

ROUYESH (Rise)

Identification of investment opportunities and industry participation in knowledge-based and startup projects

Meeting the technological needs of industries and economic enterprises that are the member of ECCIMA through:

- Incubators and accelerators in specialized areas and access to commercialization programs and etc.
- Support for startups

TABESH (Radiation

Exchange and utilization of laboratory facilities through a network

Reduction of the costs related to the equipment and laboratories as well as the optimal use of the facilities through:

- Sharing the official, educational, and production space.
- Sharing and networking equipment, laboratories and work-shops of universities

B) Specialized Departments

Specialized Departments of Innovation Center of ECCIMA & University

4.7. Isfahan Science and Technology Town (ISTT) and its Collaboration with Business

- ISTT is home of the UNESCO Center for Technology Incubator and Science Park Development.
- ISTT has become a poineering model for the management of technology incubators and science parks across Iran.
- ISTT provides an environment for commercilizaing technology and attracting domestic and foreign investment.

A) The ISTT's activities and programs include:

- Organizing research and development facilities,
  Guidance to the scientific community on strategic research areas,
- Planning and creating the fields for applications and commercialization of research results, and
- Creating scientific and research space to attract scholars and specialists both at home and abroad.

4.8. A Joint Training Program on Industrial Digitalization (Industrial Revolution 4)

- Collaboration between University of Isfahan, International Universities and Mobarekeh Isfahan Complex (MISC),
- MISC is the largest steel producer in Iran, furthermore one of the largest units in the MENA region,
- International universities included in the projects:
  - Technical University München, Germany,
  - University of Freiburg, Germany
  - Zurich University of Applied Sciences, Switzerland,
  - München University of Applied Sciences, Germany.
- Objectives of the Program:
  - Leadership promotion at different organizational levels to understand the principles and concepts of digital evolution,
  - Acquiring the required managerial and technical skills to define the system requirements to implement digital transformation technologies,
  - Preparation to participate in the implementation of digital transformation technologies,
  - Creating digital values in business environment by participants.

4.9. Empirical Evidence: An Estimation between Science, Technology and Trade (Case of Iran-Vietnam)

Effects of S&T Indicators on Bilateral Trade Relations

✓***Framework***: *A Trade Gravity,* $T_{ij} = f(Y_i, Y_j, N_i, N_j, DIS_{ij}, S\&T_l)$

✓**Time Period**: 1995 – 2020

✓**Cross Sections**: 20 Exporting Goods Groups,

✓**Estimation Method**: Panel GLS

Panel Regression Model of Bilateral Trade Model (Iran-Vietnam):

$$LT_{ijt} = \beta_0 + \beta_1 LGDP_{it} * LGDP_{jt} + \beta_2 LEX_{it} + \beta_3 LEX_{jt} + \beta_4 DIS_{ijt} + \beta_5 S\&T_{lit} + \beta_6 \beta_5 S\&T_{ljt} + U_{ijt}$$

where LT_{ijt} denotes log of exports from country i to country j at time t. $LGDP_{it} * LGDP_{jt}$ is the product of the (log of) GDPs per capita (GDPit p. cap.×GDPjt p. cap.) of country i and country j in time t. LEX_{it} and LEX_{jt} denote respectively the exchange rates of county i and country j at time t. In addition, DIS_{ij} indicates the distance between two countries. $S\&T_{lit}$ *and* $S\&T_{ljt}$ show the S&T proxy for country i and j, respectively.

The Following S&T Indicators used in estimating Iran-Vietnam Trade Gravity Model such as:

Case 1: Research and development expenditure (% of GDP)

Case 2: Researchers in R&D (per million people)

Case 3: Scientific and technical journal articles

Case 4: Patent applications, residents

Case 5: Technicians in R&D (per million people)

Estimated Results for Iran-Vietnam Bilateral Trade (1995-2019)

Variable	Case 1	Case 2	Case 3	Case 4	Case 5
Cons.	7.89 [0.054]	2.567 [0.468]	.221 [0.977]	28.85 [0.000]	7.94 [0.228]
$LGDP_{it}*LGDP_{jt}$	.19 [0.006]	.0992 [0.133]	-.176 [0.014]	-.0059 [0.924]	.24 [0.009]
LEX_{it}	1.53 [0.028]	4.677 [0.000]	5.44 [0.001]	-1.343 [0.05]	-.965 [0.775]
LEX_{jt}	-.56 [0.000]	1.76 [0.000]	-1.369 [0.000]	-.842 [0.000]	2.64 [0.414]
DIS_{ijt}	-.00092 [0.000]	-.001 [0.000]	-.0006 [0.006]	-.001 [0.000]	-.00175 [0.000]
$S\&T_{1it}$	.688 [0.000]	-	-	-	-
$S\&T_{1jt}$	1.36 [0.000]	-	-	-	-
$S\&T_{2it}$	-	.0003 [0.013]	-	-	-
$S\&T_{2jt}$	-	.00023 [0.069]	-	-	-
$S\&T_{3it}$	-	-	.00001 [000]	-	-
$S\&T_{3jt}$	-	-	4.87e-06 [0.329]	-	-
$S\&T_{4it}$	-	-	-	6.73e-06 [0.019]	-
$S\&T_{4jt}$	-	-	-	.000019 [0.071]	-
$S\&T_{5it}$	-	-	-	-	5.56e-06 [0.000]
$S\&T_{5jt}$	-	-	-	-	.00096 [0.000]
Diagnostic Tests	Waldchi2=2910.66 LRchi2= 43.97	Waldchi2=3240.34 LRchi2=16.08	Wald chi2=2405.42 LRchi2=46.17	Wald chi2=2770.20 LRchi2=42.88	Wald chi2=3168.61 LRchi2=13.21

A) Estimation Analysis:

- S&T indicators have statistically positive and significant effects on bilateral trade between two countries. It implies a significant relationship between university and business (proxied here by Iran-Vietnam bilateral trade flows).
- Findings have confirmed the importance of science and technology in improving economic relations between Iran and Vietnam.
- Countries worldwide have the chance of enhancing their economic capacities through implementing S&T cooperation.

5. Concluding Remarks and Policy Implications:

This study recommends the policy of promoting scientific and technological developments through strengthening university and business collaborations for sustainable development in economies, businesses and industries based on the following concluding remarks and implications:

a) Development of Human Resource Capacity for science, technology and innovation as well as science education.
b) Strengthening institutional capacity in scientific research and technological development,
c) Scientific, Technological and Research Collaboration and Cooperation among universities, economic sectors and business worldwide.
d) Exchange/ dissemination of Information on Scientific and Technological Research and Development through workshops, conferences and meetings etc.