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Effects of college internships on the innovation capability and employability of the Mexican workforce

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in

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Abstract

It is theorized that competition in the global market requires highly skilled human capital with different types and levels of skills, and with transferable skills. Internships are intended to nurture the skills and make students better professionals, better innovators, and more likely to get employment. In this thesis I evaluated these claims by examining the effect of the skills developed by internships on the professional performance, innovation capability and employability of Mexican students. The purpose of this thesis is to evaluate both the mandatory internship program in its ability to improve employability and to test some of the educational theories of workforce improvement and of what skills contribute to workers' innovation capacity.

Internships prepare students for the workplace by giving them opportunities to develop relevant skills. The Committee on the Assessment of 21st Century Skills of the U.S. National Research Council (NRC), identified three categories of workplace skills enabling individuals to face 21st Century challenges: cognitive, interpersonal, and intrapersonal skills. I tested the relevance of these skills to interns' professional performance using intern evaluation data on interns working at a multinational enterprise in the global steel industry, Ternium Mexico. A general model of internship outcomes was used to predict Main task and learning performance internship outcomes, and ordered logistic regression was used to predict Overall internship performance. The results confirmed that (1) cognitive intelligence or technical skills are necessary but not sufficient for success in executing professional tasks and (2) certain interpersonal and intrapersonal skills were also significantly associated with better professional performance as an intern.

The ability to innovate is one of the most important and desired meta-skills for individuals, firms, and economies. It is believed that nurturing students' innovation capability will improve their employability and their ability to deal with a rapidly changing future. A recent conceptual model of Individuals' Innovation Capability, the D4 innovation model, has four stages: defining, discovering, developing, and demonstrating. Using the same internship evaluation data set, I determined whether the four D innovation skills: defining, discovering, developing and deploying skills, predicted Individuals' Innovation Capability. The study confirmed that three of the innovation skills, discovery, developing and deploying, increase Individuals' Innovation Capability. The foundation skills of oral communication and ability to self-update, and the professional competencies of establishing priorities and explicit knowledge also foster individual innovation capability.

Internships have often been required for graduation by institutions of higher education because internships are perceived to help students increase their employability as well as provide educational value. I conducted statistical analyses to test whether students' performance as interns and the number of internships they completed are predictive of their Probability of Employment, controlling for various labor-market conditions. The study analyzed the records of graduates at a private Mexican university who had completed undergraduate degrees as well as mandatory internships. A logistic regression model for job placement four months following graduation included: individual factors, personal circumstances, external conditions, and interactions with external conditions. This study revealed that the performance as an intern played an important role on employment and that employability depended on the interaction of a

graduate's personal assets, his/her family connections, and whether or not the labor market was contracting.

This thesis is an empirical exploration of educational theory concerning the value of internships and also the skills that internships should foster. Since educational policy is frequently driven by theory, such validation is a potentially useful reality-check for policy makers. This work can inform educational policy and provide the underpinnings for shaping initiatives that benefit students, firms and the region.

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Chapter 1

1. Introduction

1.1. Thesis proposition and research questions

The goal of this thesis is to understand the effects of internships on the workplace skills, innovation capability and employability of Mexican college students. This work has been undertaken to contribute to Mexican engineering education research, to foster innovative performance at firms, industrial sectors and at the national level, and ultimately to inform Mexican public and private policies concerning education and training.

The general question addressed in this thesis is what are the engineering-students' skills that the Mexican engineering education should develop to enhance the Mexican workforce's preparation to face the 21st Century Challenges? The specific questions are: 1) what skills of Mexican college students should be enhanced to foster workplace performance? 2) what skills of Mexican college students should be developed to nurture innovation capability? And 3) what are the influential factors on the Probability of Employment of recent Mexican college graduates?

The vehicle that I used to address these questions was the college internships. This thesis defines an internship as a part of the academic curriculum that offers off-campus learning activities, experiential learning, and provides students with real-world experience in organizations and the opportunity to apply and develop their knowledge,

skills and attributes while functioning as a professional. For this work, I developed models based on two assessment approaches: the academic performance assessment and the industrial performance assessment of Mexican interns.

Previous studies have reported that students received added value from internships. Internships have been said to improve or develop characteristics looked-for by employers: essential skills and attributes [1-3], personal competencies [4,5], transferable skills [1,3,5-8], job qualifications [2,3], work knowledge [4,9], professional development [2], and adaptability and mobility to a new position [2,5,9,10].

In Mexico, all college students must perform some social service, because it is a requirement of the Mexican Constitution; this service is often in the form of an internship [11, 12]. In the U.S.A. the National Survey of Student Engagement (NSSE) 2013 results show that more than 70% of the college students participate in at least one off-campus experience [13]. It shows the high interest of American universities in offering experience-based learning and students' interest in obtaining such real-world experience to enrich their profile.

In sum, in this thesis I attempt to elucidate the relationship between internship experience performance, Individuals' Innovation Capability and Employability for Mexican college seniors by generating statistical models using internship and other relevant variables.

1.2. Workplace Skills Employers Want

There are many theoretical and survey studies about workplace skills. In general, a skill is an individual capability for which there is a demand in the formal economy, which

means in the labor market or entrepreneurial world. In this thesis I used Clarke and Winch's definition of skill "… the ability to apply theoretical knowledge in a practical context" [14] where the theoretical knowledge, according to Toner, is related not only to technical subjects, it is also associated with other skills [15].

The American Society for Training and Development (ASTD) identified the essential skills employers want. The ASTD's report found seven such skill categories: the foundation, basic competencies skills, communication skills, adaptability skills, developmental skills, group effectiveness, and influencing skills [16]. The Secretary's Commission on Achieving Necessary Skills (SCANS) lists three categories of foundation skills: basic skills, thinking skills and personal qualities; and five workplace competencies: resources, information, interpersonal, systems, and technology that all college graduates need to succeed in the workplace [17]. The National Research Council's (NRC) Committee on the Assessment of 21st Century Skills created a list of skills necessary for different types of employment, from high-wage scientists and engineers to low-wage restaurant servers and elder caregivers. The NRC's 21st Century Skill Categories are: cognitive, interpersonal, and intrapersonal skills [18]. I built a general model to test internship outcomes (Main task, Learning, and Overall performance) using the three categories of 21st Century skills and an intern evaluation database on interns working at a multinational enterprise in the global steel industry, Ternium Mexico. Linear regression was used to predict Main task and Learning performance internship outcomes, and ordered logistic regression was used to predict Overall internship performance.

1.3. Innovation Theory

There is not a consensus about the definition of innovation. The Oslo Manual [19] and National Science Foundation (NSF) [20] have very similar definitions of innovation. They define innovation as the introduction or implementation of new or improved existing products, processes, organizational methods, marketing methods, workplace organization, or external relations. Other researchers define innovation as any market opportunity, policy, method or process, structure, or any product having some originality. Damanpour's definition of innovation is " … the generation, development, and adoption of new ideas or behaviors. An innovation can be a new product or service, a new production process technology, a new structure or administrative system, or a new plan or program pertaining to organizational members." [21] I used the following definition of innovation based on previous definitions; it is the generation and development of value, and adoption of new ideas or behaviors. An innovation can be an introduction or implementation of radical or incremental improvement of existing products, processes, organizational and marketing methods, workplace organization, external relations, or a new plan or program proposed by a firm's collaborator.

1.4. Individuals' Innovation Capability and the Mexican Context

Competition in the global market requires employees to be highly qualified for different types of tasks [22, 23] and have transferable skills [24]. In 2007, the European Union called for more research on the skills and competencies required for incremental innovation on products, processes, and organizational and marketing methods [25].

A 2009 OECD report opined that since Mexico had moved slowly to a growth path driven by innovation, the Government of Mexico should create policies to improve individual-level, firm-level, and governmental-level capabilities to drive innovation [26, 27]. In 2011 the Mexican Secretary of Economy created the National Innovation Plan of Mexico. The plan stated that innovation is a national priority, the Plan recommends the development of innovative skills in the workforce - among other initiatives, to increase the competitiveness of its economy and achieve the growth rates and job quality that Mexico needs [28].

Worker skills and innovation have been called the drivers of economic growth [29], and college students have been identified as the major force of the future innovations [30]. Fostering innovation skills among students requires an understanding of the antecedents of this quality, including the attributes of innovative people.

There have been a number of qualitative analyses of the attributes required for cultivating innovation. This thesis take account some of the skills from Gregory's creative and innovative skills in engineering [31], 3M inventorpreneur traits, innovative characteristics of young people [32], and 21st Century skills [18], which they should develop or consolidate if they want to become future innovators.

On the other hand, there is an emerging theoretical and empirical research movement in the field of innovation studies focused on identification, description, and categorization of skills required for innovation, and in the formation of innovation skills. For example, the D4 Model for innovation is a conceptual roadmap for the steps of innovation composed of four components: define the opportunity, discover the ideas, develop designs, and demonstrate feasibility [33].

In this thesis, I examine the theory of the determinants of individuals' innovation capacity and attempt to empirically verify it using data collected on Mexican college interns. This study analyzes performance evaluation data of interns at a multinational global steel company to develop a conceptual model as a function of three categories: foundation skills, professional competencies, and hypothesized the innovation skills. The first two categories come from the SCANS categories and the last category relates to the 4D innovation model.

1.5. The Notions of Employability

Over the last century, the concept of employability has evolved. Once a binary concept, it is now seen as interactive and adaptive [34]. Based on this notion of employability, McQuaid and Lindsay synthetized a definition that includes three components: (a) individual factors (b) personal circumstances, and (c) external context factors related to labor market conditions, employment regulations, and the effectiveness of the job matching process [35]. Yorke defined employability as a probabilistic process, as "a set of achievement–skills, understandings and personal attributes– that makes graduates more likely to gain employment and be successful in their chosen occupations, which benefits themselves, the workforce, the community and the economy." [36]

This thesis uses the following definition of employability, it is the ability to adapt knowledge, skills, attributes and experience for future employment and entrepreneurial opportunities, it is also a probabilistic process where more than the individual factors play a role in the job matching process. For this thesis I analyzed a Stratified Random Sample of the records of graduates at a private Mexican university who had completed

undergraduate degrees in business, design, and engineering as well as mandatory internships. I considered a logistic regression model for the Probability of Employment, which included three categories of factors: individual, personal circumstances and external factors.

1.6. The Mexican Legal Internship Framework

Mexican college students must participate in a mandatory internship program established by Mexican Law [11, 12]. The Mexican Constitution and under related laws and regulations for obtaining a higher education degree mandates Social Service by college students [11]. The Social Service is implemented under two approaches: (a) socially-oriented experience, and (b) professionally-oriented experience – the internship. An internship program is permitted for a regular student who meets some academic requirements, and the Mexican Law of Professions requires an internship tutor to advise, support and assess interns. The Law of Professions states that the Department of Education must authorize each internship program [12].

The general internship process follows a standard pattern. The firm's department of human resources visits HEIs to identify students who meet the internship criteria established by the Law. Firms propose problems/projects involving interns in spring, summer and fall. The students apply for the project they want, and are interviewed and assessed by the firm project owner, also called the internship tutor. Once students are accepted as an intern, they should plan and organize their time in order to meet the objectives of the internship. At the end of the academic period or of the internship, each intern is assessed as an employee and the firm sends an internship completion letter to the

student's university.

1.7. General Methodology

This thesis used Structural Equation Modeling, a methodology generally used in social sciences to study complex relationship among multiple attributes in determining an effect [37]. This approach uses a statistical method to identify the significant variables in a model that quantifies the relationship between the outcome of interest and its predictive variables.

The independent variables were defined using theoretical categories to determine their relevance to the assorted outcomes of interest, the dependent variables. The statistical methods were selected according to the nature of the dependent variable. These methods were used to analyze quantitative data and qualitative information collected through questionnaires. This approach sorts out the significant variables and estimate their coefficients to arrive at a model that quantifies the contribution of the significant variables that can be considered determinants for dependent variable. Table 1.1 shows a general methodology of eight-steps.

Table 1.1 The General Methodology used in this thesis

Step	Description
Step 1	Define a research question and its particular hypotheses.
Step 2	Conceptualize a general model and define the dependent and independent variables.
Step 3	Design and pilot a questionnaire, randomized selection or census to collect and assemble a database.
Step 4	Perform multicollinearity tests to identify which of the variables should be kept or dropped from the database.
Step 5	Once the multicollinearity criterion has been met, an internal data consistency test and explanatory descriptive analysis is executed.

Step 6	Perform the structural equation modeling. A set of models should be tested to find the best one. Once the best model is found, residuals are tested for heteroskedasticity. Tests for model specification error and for omitted variables problems are also performed.
Step 7	Interpret the results.
Step 8.	Formulate conclusions and discussion.

Chapter 2

2. Assessing the Role of 21st Century Skills on Internship Performance Outcomes

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Abstract

Internships prepare students for the workplace by giving them opportunities to develop relevant skills. The Committee on the Assessment of 21st Century Skills of the U.S. National Research Council (NRC), the operating arm of the National Academy of Sciences (NAS), has been developing definitions of workplace skills enabling individuals to face 21st Century challenges. In 2010 the Committee defined three categories of skills underpinning a broad range of jobs: cognitive, interpersonal, and intrapersonal. The goal of this paper is to identify the NRC 21st Century skills that are related to measured internship performance outcomes.

The three outcomes we studied are execution of the internship Main tasks, Learning task-related new knowledge, and Overall internship performance. The subjects for this study

include interns participating in a Mexican National Internship Program from summer 2006 to summer 2010 working at a multinational enterprise in the global steel industry, Ternium Mexico. Intern performance data had been collected using a unique instrument that was developed to evaluate the professional performance of the full time employees of the firm. A general model of internship outcomes was created using the three categories of 21st Century skills. Linear regression was used to predict Main task and Learning new knowledge, and ordered logistic regression was used to predict Overall internship performance. The results confirmed that (1) cognitive intelligence or technical skills are necessary but not sufficient for success in executing professional tasks and (2) certain interpersonal and intrapersonal skills were also significantly associated with better professional performance as an intern.

2.1. Introduction

Competition in the global market requires employees to be highly qualified for different types of tasks [22, 23] and have transferable skills [24]. In 2007, the European Union called for more research on the skills and competencies required for incremental innovation on products, processes, and organizational and marketing methods [25].

Clarke and Winch defined skill as "an attribute or property of an individual, associated with the performance of specific tasks, associated with physical or manual dexterity and is not necessarily associated with a particular knowledge base." Clarke and Winch also defined skill in an industrial framework as "the ability to apply theoretical knowledge in a practical context" [14]. In 2011, Toner added that the notion of "the theoretical knowledge encompasses not just technical subjects, but mathematics, work

planning, autonomous working, problem solving and critical thinking." [15]

The NRC Committee on the Assessment of 21st Century skills has created a list of skills necessary for different types of employment, from high-wage scientists and engineers to low-wage restaurant servers and elder caregivers. The NRC defined three categories of skills that will be the independent variables in this study: 1) Cognitive skills: problem solving (non-routine), critical thinking, systems thinking, information/ ICT literacy, creativity, and learning to learn/meta-cognitive skills; 2) Interpersonal skills: complex communication, social skills, teamwork/collaboration, social-cultural sensitivity, responsibility, tolerance for diversity, emotional/social intelligence, and leadership; and 3) Intrapersonal skills: self-management, time management, self-development, self-regulation, adaptability, flexibility, executive functioning, core self evaluation, persistence, study skills, ethics & integrity, and citizenship [18, 38].

Previous studies have investigated the skills that will be required in the 21st Century. Some have focused on specific skills such as critical thinking [39, 40, 41], while others have studied categories of skills independently, including cognitive skills [42. 43, 44], social skills [45, 46], self-regulation [47, 48], and intrapersonal skills [49]. A few other studies have investigated more than one skill or category of skills simultaneously such as the effect of cognitive and interpersonal skills on individual performance [50]. A more recent theoretical discussion of professional performance considered multiple aspects such as thinking and working skills, working tools, and living in the world skills [51].

Empirical studies (based on data on individual employees) have modeled the impact of cognitive and non-cognitive ability on income [52], and some colleges have been using standardized tests and non-cognitive skill tests to assess correlations between admission

scores and professional effectiveness [53].

Researchers agree that cognitive intelligence or technical skills are needed, but not sufficient to have success in executing complex professional tasks and that interpersonal and intrapersonal skills improve performance [54, 55]. Some authors hold that the cognitive skill is the basic determinant of labor market outcomes [56]. In contrast, others researchers have stated that "Non-cognitive ability is as important, if not more important, than cognitive ability." [57] Globalization and world class competitiveness requires teamwork skills, occupational competencies, applying theoretical learning in practical solutions, routine and non-routine problem solving, the ability to deal with uncertainty, verbal and written communication skills, the understanding of needs of external and internal customers, and the ability to engage with external suppliers, among other skills [23].

The present study empirically relates the NRC 21st Century Skills Categories to internship performance metrics using data from industrial internship performance reports.

In Mexico, college students must participate in a country-wide mandatory internship program established by Mexican [11, 12]. Firms propose projects involving interns in spring, summer and fall. The firm's department of human resources visits universities and technological institutes to identify students who meet the internship criteria. The students select the project they want, and are interviewed and accepted by the firm project owner, also called the internship tutor. Mexican Law of Professions requires an internship tutor to advise, support and assess interns [12]. Students plan and organize their time in order to meet the Objectives, Main tasks, and Learning goals to complete the internship. At the end of the academic period, each intern is assessed as an employee and the firm sends an

internship completion letter to the student's university. This study used national level information regarding a Mexican Internship Program of a steel multinational enterprise. The internship tutor uses the same instrument to evaluate regular employees to assess interns, evaluating the internship outcomes: (1) mastering Main tasks, (2) Learning new knowledge, and (3) Overall performance.

2.2. Methodology

This study used Structural Equation Modeling, a methodology generally used in social sciences to study complex relationships among multiple attributes in determining an effect [37]. In this study, the success of the internship is hypothesized to be the result of the students having and developing a set of skills. The various skills are the input variables, and the internship success is the function of these variables that produces the desired outcome. This approach uses a statistical method to sort out the significant variables and estimate their coefficients to arrive at a model that quantifies the contribution of the significant variables that can be considered determinants for internship success.

In brief, we define the independent and dependent variables that describe the experience and use a statistical analysis of qualitative questionnaire-based data for testing our research hypotheses, described below. A methodology in eight-steps was used, which is explained in Table 2.1.

Table 2.1 Methodology for internship performance outcomes

Step	Description
Step 1	Set a research question and its particular hypotheses.

Step 2	Conceptualize a general model and define the dependent and independent variables.
Step 3	Assemble the data of the interns' outcomes performance.
Step 4	Perform multicollinearity tests to identify which of the variables should be kept and/or dropped from the database to execute the structural model to be able to answer the research question and finally test the hypotheses.
Step 5	Once the multicollinearity criterion has been met, an internal data consistency test and explanatory descriptive analysis can be executed
Step 6	Execute the structural equation modeling, using at least one regression method to run the structural model in accordance with the type of the dependent variable. A set of models should be tested to find the best one, ensuring that each new model met the overall significance of the regression and improve the R-squared. Once the best model is found; it was tested for heteroskedasticity, model specification error and for omitted variables problems.
Step 7	Interpret the results.
Step 8.	Formulate conclusions and discussion.

In the following paragraphs, each of the steps is shown in detail.

2.3. Research Questions and Hypotheses

This study addresses whether the three NRC skill categories are determinants of intern performance. The hypotheses are listed in the following Table 2.2:

Table 2.2 List of hypotheses for internship performance outcomes

Number	Hypotheses
H1	Understanding of internal and external clients is a cognitive skill that improves at least one of the following internship outcomes: accomplishing Main tasks, Learning new knowledge, and Overall performance as an intern.
H2	Planning and organizing ability is a cognitive skill that increases at least one of the internship outcomes.
H3	Applying theoretical learning to practical solutions is a cognitive skill that fosters at least one of the internship outcomes.
H4	Collaboration ability is an interpersonal skill that impacts at least one of the internship outcomes.
H5	Proactivity and self-updating is an intrapersonal skill that influences at least one of the internship outcomes.
H6	Ability to work in ambiguous situations is an intrapersonal skill that influences at least one of the internship outcomes.

2.4. Conceptual Model

Figure 2.1 shows the conceptual model of the relationships of skills to internship performance outcomes. The independent variables are related to the NRC skill categories. The cognitive category includes skills such as understanding needs of internal and external clients, planning and scheduling internship activities, finding relevant information, practical ability to apply his/her technical competencies, good judgment implementing his/her ideas, and writing reports to share information. The interpersonal category contains skills such as oral communication, network building, working with members from other areas, and ability to coordinate tasks in a group. The intrapersonal category contains the following skills: proactivity for his/her professional self-updating, seeking feedback, tolerating frustration due to difficulties and failures, working in ambiguous situations, and recognizing and appraising contributions from others. We control for the variables gender, academic period, major, type of higher education institution, and firm division where the internship took place. There were four dependent variables to assess intern performance: 1) the performance of Main tasks, 2) the Capacity to learn new knowledge, 3) the Project execution, and 4) Overall performance to execute the internship.

2.5. Method of Collecting Data

The dependent and independent variables were collected using an instrument designed, piloted, and applied for evaluating the professional performance of the full time employees in the firm each year, and intern performance each academic period (spring,

summer and fall). The firm has used this instrument for more than 10 years in all its plants around the world.

The database was composed of the assessments of all students interning from summer 2006 to summer 2010, covering 500 students who completed a first internship.

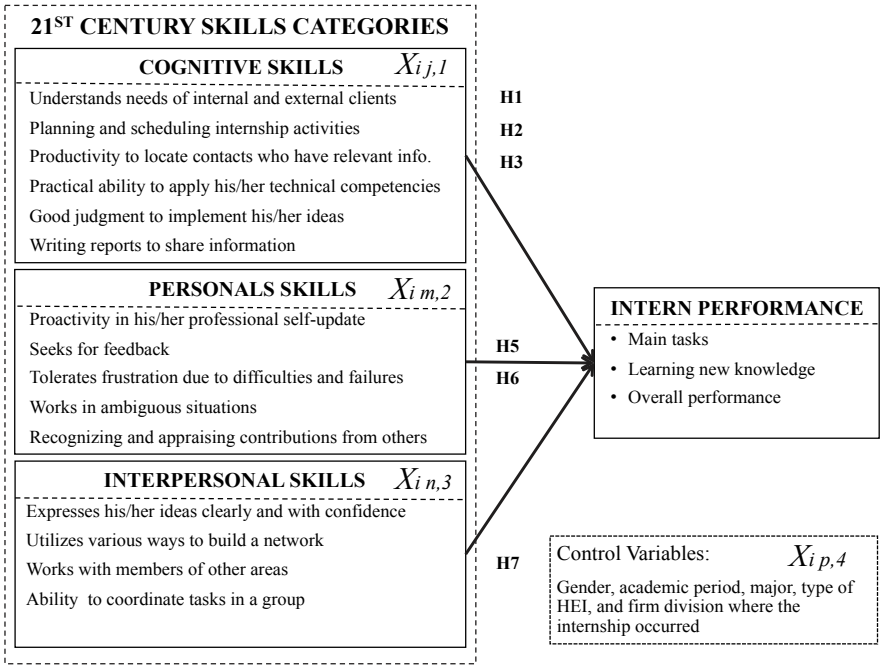

Figure 2.1 A conceptual model of professional performance of an intern

The evaluation instrument was organized into two parts. Section A., intern objectives, and Section B., professional skills needed in the firm. Section A assessed the performance of tasks assigned to the interns, how well they learned new knowledge, the quality of project execution, and overall performance as an intern. Section B assessed 43 skills divided in six subsections: 1. Professional expertise (6 skills), 2. Business management (6 skills), 3. Drive for results (7 skills), 4. Client focus (2 skills). 5. Interpersonal skills including teamwork (6 skills), communication (4 skills), and

leadership (3 skills); and 6. Sharing knowledge that included searching for information (2 skills), using and applying knowledge (2 skills), sharing knowledge (2 skills), and explicit knowledge (3 skills). A five-point Likert scale was used in each question in the evaluation instrument, where 5 = very good performance, 4 = good performance, 3= satisfactory performance, 2 = poor performance, and 1 = very poor performance. At the end of the academic period, the internship tutor assessed each intern, using the same instrument of evaluation that the firm uses for the regular employees.

2.6. Multicollinearity Testing

The multicollinearity testing of all dependent and independent variables in the evaluation instrument included the bivariate correlation test, the tolerance test (T), and the variation inflation factor test (VIF). Tests showed that all values of T were >0.29 and VIF were <3.5, showing no multicollinearity problems in the data. Furthermore, we dropped independent variables having bivariate correlations greater than 70% with any of the other variables. The first column of Table 2.3 shows the independent variables kept in the study, and in the second column are the independent variables dropped to avoid multicollinearity problems. In addition, one of the dependent variables, Project execution, was dropped due to its high correlation with Performance of main tasks.

Table 2.3 List of independent variables kept and dropped in the study

Variables kept in the Database	**Variables dropped due to multicollinearity**
1. Professional Expertise	
Practical ability to apply his/her Professional Competences	Possesses specific knowledge and skills of his/her profession
Good judgment to implement his/her ideas	Shows maturity about his/her professional growth expectations
Utilizes various ways to network building	
Proactive in his/her professional self-update	
2. Business management	

Planning and scheduling his/her activities	Connects project objectives with the company's objectives
	Aligns projects activities with sector targets
	Establishes priorities and reports achieved results on time
	Recognizes mistakes and reacts with a continuously improving attitude
	Makes it his/her job to achieve all quality standards
3. Drive for results	
Tolerates frustration due to difficulties and failures	Responsible for his/her specific role
Works in ambiguous situations	Completes tasks and achieves the objectives
	Exceeds requirements and goes beyond
	Self-motivation without external stimuli
	Maintains his/her effectiveness under pressure
4. Client focus	
Understands needs of internal and external clients	Considers the impact of his/her tasks on other projects
5. Interpersonal skills: Teamwork	
Works with members of other sectors	Achieves an appropriate link with his/her leader
Recognizes and appraises contributions from others	Integrates his/her work with his/her sector/department
	Contributes to a good working environment
	Ability to work in multidisciplinary/multicultural teams
	Listens and understands ideas of speaker
5. Interpersonal skills: Communication	
Seeks feedback	Listens and understands ideas of speaker
Expresses his/her ideas clearly and with confidence	Presents reports in a professional way
5. Interpersonal skills: Leadership	
Has ability to coordinate group tasks	Influences his/her group by persuasion and consensus
	Commands respect and authority
6. Sharing knowledge: Searching information	
Proactively locates contacts who have relevant information	Finds relevant information for his/her project
6. Sharing knowledge: Using and applying knowledge	
	Takes advantage of the existing knowledge of the firm
	Avoids designing processes or tasks from scratch
6. Sharing knowledge: Sharing knowledge	
Writes report for information sharing	Shows a positive attitude towards sharing knowledge
6. Sharing knowledge: Explicit knowledge	
	Makes documents to share knowledge
	Develops industrial and administrative procedures for the tasks performed
	Inventories best practices for his/her project

2.7. Data Internal Consistency Test and Explanatory Descriptive Analysis

In addition to the multicollinearity tests, the Cronbach's alpha test was used to evaluate the internal consistency of responses. Alphas of 0.70 or higher are considered to be acceptable. Table 2.4 shows that all alphas exceeded 0.88.

Table 2.4 Internal consistency tests for each item in the questionnaire, each NRC skill category, and for the whole model (Cronbach's α)

NRC's Skills Category	Skill assessed	Cronbach's α			
		Skill	Category	Skill	Whole Model
Cognitive Skills	Understands needs of internal and external clients	0.90	0.91	0.96	0.96
	Planning and scheduling his/her activities	0.90		0.96	
	Proactive to locate contacts who have relevant information	0.90		0.96	
	Practical ability to apply his/her Professional Competences	0.90		0.96	
	Good judgment to implement his/her ideas	0.90		0.96	
	Writes reports to share information	0.9		0.96	
Intra-personal Skills	Proactive in his/her professional self-update	0.88	0.90	0.96	
	Seeks feedback	0.89		0.96	
	Tolerates frustration due to difficulties and failures	0.87		0.96	
	Works in ambiguous situations	0.87		0.96	
	Recognizes and appraises contributions from others	0.86		0.96	
Inter-personal Skills	Expresses his/her ideas clearly and with confidence	0.85	0.88	0.96	
	Utilizes various ways to network building	0.86		0.96	
	Works with members of other sectors	0.84		0.96	
	Has ability to coordinate group tasks	0.85		0.96	

Table 2.5 shows the firm's skills categories, the NRC's skill categories, and the skills/variables that were kept in the study.

Table 2.5 Skill variables used in the models of intern performance

Firm's categories and questions	NRC's skill categories and firm's questions in the model
1. Professional Expertise	**1. Cognitive Skills**
Practical ability to apply his/her Professional	Understands needs of internal and external clients
Good judgment to implement his/her ideas	Planning and scheduling his/her activities
Utilizes various ways to network building	Proactive to locate contacts who have relevant information
Proactive in his/her professional self-update	Practical ability to apply his/her Professional Competences
2. Business management	Good judgment to implement his/her ideas
Planning and scheduling his/her activities	Writes reports to share information
3. Drive for results	**2. Intrapersonal Skills**
Tolerates frustration due to difficulties and failures	Proactive in his/her professional self-update
Works in ambiguous situations	Seeks feedback
4 Client focus	Tolerates frustration due to difficulties and failures
Understands needs of internal and external clients	Works in ambiguous situations
5. Interpersonal skills: Teamwork	Recognizes and appraises contributions from others
Works with members of other sectors	**3. Interpersonal skills**
Recognizes and appraises contributions from others	Expresses his/her ideas clearly and with confidence
5. Interpersonal skills: Communication	Utilizes various ways to network building

Seeks feedback	Works with members of other sectors
Expresses his/her ideas clearly and with confidence	Has ability to coordinate group tasks
5. Interpersonal skills: Leadership	
Has ability to coordinate group tasks	
6. Knowledge sharing: Searching information	
Proactive to locate contacts who have relevant	
6. Knowledge sharing; Sharing knowledge	
Writes reports to share information	

Table 2.6 shows a summary of the interns' average scores on the six cognitive skills, four interpersonal skills, and five intrapersonal skills, and five control variables sorted by the interns' overall performance level. This table also includes the average scores for three dependent variables, the interns' performance of main tasks, how well they learned new knowledge, and their overall performance.

The first two columns represent the independent variables and the next eight columns show the mean and standard deviation for independent variables related with the three NRC skills categories and number of interns falling in the categories of the control variables. The control variables are not continuous like the other independent variables, but are categorical variables. Their numerical values are indicated in parentheses in this table.

Three hundred ten males and 190 women were in the cohort. One hundred fifty-four internships were completed in summertime, 126 in the fall semester, and 220 in springtime. One hundred sixty-nine industrial engineers, 62 chemical engineers, 127 material and mechanical engineers, 77 electronic engineers, 50 business majors; and 15 from other academic programs participated in the 500 internships. There were 157 interns from private technological institutions; 112 from private universities, 26 from public technological institutions, and 205 from public universities.

Table 2.6 Average internship skill scores and control variable values by internship performance outcome level

Independent Variables		Dependent Variable							
		Main tasks Learning		Overall performance					
NRC's Skills Category	Skills and Attributes assessed by the firm Variables (j)			Unsatis-factory n=14		Satisfactory n=216		Above Satisfactory n=270	
		Mean	*sd*	*Mean*	*sd*	*Mean*	*sd*	*Mean*	*sd*
Cognitive Skills (x_{1ij})	Understands needs of internal and external clients	3.62	0.80	2.43	1.02	3.12	0.52	4.09	0.66
	Planning and scheduling his/her activities	3.61	0.83	2.43	0.85	3.15	0.65	4.04	0.70
	Proactive to locate contacts who have relevant information	3.61	0.83	2.29	0.99	3.15	0.64	4.04	0.69
	Practical ability to apply his/her Professional Competences	3.72	0.75	2.64	1.01	3.27	0.50	4.14	0.62
	Good judgment to implement his/her ideas	3.65	0.79	2.36	0.84	3.20	0.54	4.08	0.68
	Writes reports to share information	3.72	0.84	2.29	0.99	3.20	0.55	4.21	0.67
Intra-Personal Skills (x_{2ij})	Proactive in his/her professional self-update	3.69	0.81	2.29	0.83	3.25	0.56	4.11	0.70
	Seeks feedback	3.60	0.86	2.21	0.97	3.23	0.67	3.97	0.79
	Tolerates frustration due to difficulties and failures	3.59	0.81	2.21	1.05	3.14	0.57	4.01	0.69
	Works in ambiguous situations	3.55	0.83	2.21	1.05	3.08	0.55	4.00	0.71
	Recognizes and appraises contribution from others	3.74	0.82	2.50	1.02	3.28	0.52	4.18	0.74
Inter-Personal Skills (x_{3ij})	Expresses his/her ideas clearly and with confidence	3.54	0.80	2.21	0.80	3.08	0.53	3.98	0.69
	Utilizes various ways to network building	3.58	0.79	2.36	1.01	3.14	0.52	4.00	0.70
	Works with members of other sectors	3.68	0.84	2.43	1.09	3.19	0.58	4.14	0.71
	Has ability to coordinate group tasks	3.51	0.83	2.43	1.09	3.07	0.60	3.92	0.75
Control Variables		***Freq***	***%***	***Freq***	***%***	***Freq***	***%***	***Freq***	***%***
Control Variables (x_{4ij})	Male	310	62	26	5%	122	24	162	32
	Female	190	38	22	4%	95	19	73	15
	Summer	154	31	12	2%	63	13	79	16
	Fall	126	25	15	3%	62	12	49	10
	Spring	220	44	21	4%	92	18	107	21
	Industrial	169	34	16	3%	74	15	79	16
	Chemical	62	12	6	1%	30	6%	26	5%
	Materials and Mechanical	127	25	15	3%	53	11	59	12
	Business	50	10	7	1%	25	5%	18	4%
	Electronics	77	15	4	1%	26	5%	47	9%
	Others	15	3%	0	0%	9	2%	6	1%
	Private Technological Institutions	157	31	15	3%	59	12	83	17
	Public Technological Institutions	26	5%	0	0%	13	3%	13	3%
	Public Universities	205	41	24	5%	89	18	92	18
	Private Universities	112	22	9	2%	56	11	47	9%
	Human resources	185	37	8	2%	82	16	95	19
	Engineering and Technology	82	16	3	1%	45	9%	34	7%
	Management and Finance	28	6%	2	0%	7	1%	19	4%
	Operations	205	41	1	0%	82	16	122	24

Where x = component of the model, i = individual's identifier, j = independent variable number. N= 500

2.8. Linear and ordered logistic models of internship performance outcomes

Because there were few scores in the highest and lowest categories of the dependent variables, I found it necessary to compact the five-point scale to a three-point scale for the ordered logistic regression of overall internship performance. This allowed the data to meet the parallel lines assumption.

The six hypotheses were tested using linear and ordered logistic regressions. Equation 2.1 represents the linear model form. Linear models predicted two internship outcomes (y_i): accomplishing Main tasks performance and Learning task-related new knowledge. Equation 2.2 represents the ordered logistic model for Overall intern performance. [1]

$$y_i = \beta_o + \beta_1 x_{ij,1} + \beta_2 x_{im,2} + \beta_3 x_{in,3} + \beta_4 x_{ip,4} + u_i \quad [2.1]$$

$$y_i^* = X_{ij,1}\,\beta_1 + X_{im,2}\,\beta_2 + X_{in,3}\,\beta_3 + X_{ip,4}\,\beta_4 + \varepsilon_i \quad [2.2]$$

Where y^*_i = the latent variable representing the interns' overall performance. X_1 to X_4 are matrixes of independent variables. The index for interns is i = [1, 2, … 500] and, u_i and ε_i are the error terms. The independent variables were categorized thus: cognitive skills ($\boldsymbol{x}_{1ij}, X_{ij,1}$), intrapersonal skills ($\boldsymbol{x}_{2ij}, X_{ij,2}$), interpersonal skills ($\boldsymbol{x}_{3ij}, X_{ij,3}$), and control variables ($\boldsymbol{x}_{4ij}$, $X_{ij,4}$).

Equation 2.2 is similar to that for the binary regression model, except that there are now two cutpoints $\tau 1$, and $\tau 2$. The two cutpoints lead to three levels of interns' Overall performance (y_i), as showing below. The observed response categories are tied to the latent interns' overall performance (y^*_i). For the ordered logistic regression, the cutpoints

[1] StataCorp. 2012. *Stata Statistical Software: Release 12*. College Station, TX: StataCorp LP.

were estimated using the collapsed three-level Likert scale.

$$y_i = \begin{cases} 1 \Rightarrow \text{Unsatisfactory Overall Performance} & \text{if } \tau_0 = -\infty \leq y_i^* < \tau_1 \\ 2 \Rightarrow \text{Satisfactory Overall Performance} & \text{if } \tau_1 \leq y_i^* < \tau_2 \\ 3 \Rightarrow \text{Above Satisfactory Overall Performance} & \text{if } \tau_2 \leq y_i^* < +\infty \end{cases}$$

The two cutpoints, τ_1 and τ_2, define the three levels of Individuals' Overall Performance (y_i), as shown above.

Four models were built; each subsequent model is nested in the previous model. Model 1 includes only the control variables; Model 2 adds interpersonal skills; Model 3 adds intrapersonal skills; and Model 4 adds cognitive skills. Table 2.7 shows the four models for Main tasks performance, and Table 2.8 shows the four models for Learning new knowledge. The Breusch-Pagan and Cook-Weisberg test for heteroskedasticity showed that the errors from the Main tasks and Learning performance models passed the homoscedastic residuals assumption.

The best additive model for the dependent variable, Main tasks performance, was the Model 4 (F=3.99, p = 0.002). The Akaike Information Criterion decreased from 1045 for Model 1, to 448 for Model 4. The R-squared also improved from 0.17 for Model 1, to 0.72 for Model 4.

Table 2.7 Linear models for Main tasks performance

Compo-nents	Skill assessed by the firm Firm intern evaluation	Model 1			Model 2			Model 3			Model 4		
		ß		p	ß		p	ß		p	ß		p
Cognitive Skills	Understands needs of internal and external clients										0.19	***	0.000
	Planning and scheduling internship activities										0.09	**	0.002
	Proactivity to locate contacts who have relevant info.										-0.07	*	0.020
	Practical ability to apply his/her technical competencies										0.08	*	0.031
	Good judgment to implement his/her ideas										0.07	*	0.048
	Writing reports to share information										0.12	**	0.001
Intra-	Proactivity in his/her							0.09	*	0.010	0.04		0.242

personal Skills	professional self-update											
	Seeks for feedback							-0.03		0.343	-0.06	+	0.054
	Tolerates frustration due to difficulties and failures							0.12	**	0.001	0.06		0.104
	Works in ambiguous situations							0.14	***	0.000	0.09	**	0.009
	Recognizing and appraising contributions from others							0.09	*	0.022	0.04		0.296
Inter-personal Skills	Expresses his/her ideas clearly and with confidence				0.21	***	0.000	0.12	**	0.001	0.05		0.178
	Utilizes various ways to build a network				0.22	***	0.000	0.10	**	0.004	0.06		0.102
	Works with members of other areas				0.18	***	0.000	0.12	**	0.001	0.08	*	0.021
	Ability to coordinate tasks in a group				0.15	***	0.000	0.05		0.128	0.03		0.453
Control Variables	Female *(Baseline=male)*	0.02		0.820	0.03		0.483	0.03		0.429	0.02		0.617
	Fall	0.01		0.885	-0.02		0.764	-0.02		0.714	0.02		0.743
	Spring	0.04		0.634	0.02		0.620	-0.01		0.848	0.01		0.890
	Chemical *(Baseline=industrial)*	-0.09		0.396	0.05		0.475	0.06		0.393	0.09		0.145
	Materials and Mechanical	-0.11		0.206	0.02		0.745	-0.01		0.860	0.03		0.510
	Business	-0.13		0.314	0.10		0.226	0.09		0.280	0.09		0.222
	Electronics	-0.08		0.449	-0.10		0.121	-0.13	*	0.029	-0.07		0.227
	Others	0.06		0.749	0.10		0.423	0.05		0.646	0.17		0.102
	Public Tech Institutions *(Baseline=Private Tech Institution)*	0.27	+	0.092	0.17	+	0.093	0.17	+	0.073	0.22	*	0.012
	Public Universities	0.10		0.261	0.09	+	0.091	0.10	+	0.063	0.11	*	0.026
	Private Universities	0.01		0.905	0.06		0.308	0.06		0.263	0.05		0.299
	Engineering and Technology *(Baseline=Human Resources)*	0.12		0.233	0.04		0.510	0.04		0.469	0.09		0.123
	Management and Finance	0.28		0.102	-0.01		0.889	-0.03		0.745	0.02		0.818
	Operations	0.27	**	0.001	0.10	+	0.066	0.08		0.135	0.11	*	0.023
	Constant	3.51	***	0.000	0.82	***	0.000	0.65	***	0.000	0.41	***	0.000
	R-squared	0.17			0.62			0.67			0.72		
	F Statistic	7.0			43.5			15.0			4.0		
	p-value	0.000			0.000			0.000			0.002		
	Parameters	15			16			24			30		
	Akaike Information Criterion	1045			587			523			448		

+ p < 0.1, * p < 0.05, ** p < 0.01, *** p < 0.001

Similarly the best additive model for Learning new knowledge was the Model 4 (F=5.02, p = 0.000), the model with variables from all the skill categories and control variables. The Akaike Information Criterion was reduced from 1392 for Model 1, to 1253 for Model 4. The R-squared also improved from 0.03 for Model 1to 0.41 for Model 4.

Table 2.8 Linear models for Learning new knowledge

Compo-nents	**Skill assessed by the firm Firm intern evaluation**	**Model 1**		**Model 2**		**Model 3**		**Model 4**		
		ß	**p**	**ß**	**p**	**ß**	**p**	**ß**	**p**	
Cognitive Skills	Understands needs of internal and external clients							0.29	***	0.000
	Planning and scheduling internship activities							0.08		0.243
	Proactivity to locate contacts							-0.06		0.416

	who have relevant info.												
	Practical ability to apply his/her technical competencies										0.09		0.257
	Good judgment to implement his/her ideas										0.15	+	0.064
	Writing reports to share information										0.09		0.252
Intra-personal Skills	Proactivity in his/her professional self-update							0.09	*	0.010	0.04		0.242
	Seeks for feedback							-0.03		0.343	-0.06	+	0.054
	Tolerates frustration due to difficulties and failures							0.12	**	0.001	0.06		0.104
	Works in ambiguous situations							0.14	***	0.000	0.09	**	0.009
	Recognizing and appraising contributions from others							0.09	*	0.022	0.04		0.296
Inter-personal Skills	Expresses his/her ideas clearly and with confidence				0.13	+	0.085	0.04		0.645	-0.06		0.426
	Utilizes various ways to build a network				0.24	**	0.001	0.10		0.169	0.04		0.604
	Works with members of other areas				0.14	+	0.064	0.07		0.347	0.01		0.846
	Ability to coordinate tasks in a group				0.11		0.130	0.00		0.952	-0.04		0.551
Control Variables	Female *(Baseline=male)*	0.10		0.301	0.11		0.202	0.12		0.157	0.11		0.200
	Fall	-0.61	***	0.000	-0.65	***	0.000	-0.66	***	0.000	-0.63	***	0.000
	Spring	-0.91	***	0.000	-0.92	***	0.000	-0.98	***	0.000	-0.97	***	0.000
	Chemical *(Baseline=industrial)*	-0.19		0.214	-0.07		0.596	-0.07		0.594	-0.03		0.840
	Materials and Mechanical	0.00		0.977	0.09		0.419	0.06		0.575	0.10		0.315
	Business	-0.03		0.871	0.16		0.341	0.15		0.381	0.15		0.354
	Electronics	-0.10		0.458	-0.13		0.303	-0.18		0.156	-0.11		0.368
	Others	-0.28		0.285	-0.27		0.265	-0.32		0.181	-0.17		0.453
	Public Tech Institutions *(Baseline=Private Tech Institution)*	0.12		0.588	0.02		0.909	0.03		0.868	0.09		0.650
	Public Universities	0.05		0.658	0.04		0.699	0.05		0.630	0.06		0.546
	Private Universities	0.10		0.433	0.12		0.266	0.11		0.306	0.10		0.362
	Engineering and Technology *(Baseline=Human Resources)*	0.19		0.174	0.12		0.358	0.12		0.342	0.17		0.162
	Management and Finance	0.11		0.637	-0.14		0.526	-0.14		0.518	-0.09		0.685
	Operations	0.24	*	0.041	0.09		0.405	0.08		0.473	0.11		0.306
	Constant	3.40	***	0.000	1.24	***	0.000	1.01	***	0.000	0.71	**	0.006
	R-squared	0.03			0.33			0.37			0.41		
	F Statistic	1.2			13.4			5.2			5.0		
	p-value	0.3			0.000			0.000			0.000		
	Parameters	15			19			24			30		
	Akaike Information Criterion	1392			1289			1272			1253		

+ $p < 0.1$, * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Once the best linear regression models were found, tests were run to detect model specification error and to detect omitted variables. The best model for Main task execution and Learning new knowledge passed both the specification error and the omitted variables tests.

Table 2.9 shows the four models for internship overall performance. The residuals for

the best linear model for Overall performance as an intern did not meet the homoscedastic residuals assumption, because of residual variation associated with gender. Therefore, it was necessary to use an ordered logistic model corrected by heteroskedasticy. Model 4* is the best model of the group, the asterisk indicating the heteroskedasticity correction.

Table 2.9 Ordered logistic models for overall performance

Compo-nents	Skill assessed by the firm Firm intern evaluation	Model 1			Model 2			Model 3			Model 4*		
		OR		p	OR		p	OR		p	OR		p
Cognitive Skills	Understands needs of internal and external clients										5.14	***	0.000
	Planning and scheduling internship activities										1.80	+	0.055
	Proactivity to locate contacts who has relevant info.										1.18		0.613
	Practical ability to apply his/her technical competencies										2.54	*	0.017
	Good judgment to implement his/her ideas										1.55		0.256
	Writing reports to share information										4.01	***	0.000
Intra-personal Skills	Proactivity in his/her professional self-update							2.54	***	0.000	2.22	*	0.026
	Seeks for feedback							0.89		0.618	0.64		0.145
	Tolerates frustration due to difficulties and failures							1.92	*	0.020	1.10		0.812
	Works in ambiguous situations							2.07	**	0.005	1.88	+	0.079
	Recognizing and appraising contributions from others							1.20		0.512	1.00		1.000
Inter-personal Skills	Expresses his/her ideas clearly and with confidence				4.04	***	0.000		***	0.000	1.81		0.111
	Utilizes various ways to build a network				2.84	***	0.000	1.54		0.115	0.99		0.977
	Works with members of other areas				2.81	***	0.000	2.48	**	0.001	2.24	*	0.028
	Ability to coordinate tasks in a group				1.54	+	0.061	0.88		0.626	0.69		0.307
Control Variables	Female (Baseline=male)	0.98		0.932	1.11		0.695	1.15		0.624	1.02		0.965
	Fall	0.93		0.782	0.71		0.378	0.65		0.292	0.68		0.470
	Spring	0.99		0.965	0.81		0.508	0.61		0.149	0.44	+	0.090
	Chemical (Baseline=industrial)	0.64		0.162	0.75		0.506	0.76		0.568	1.05		0.945
	Materials and Mechanical	0.93		0.786	1.38		0.349	1.22		0.578	2.20		0.104
	Business	0.46	+	0.050	0.72		0.536	0.65		0.428	1.00		1.000
	Electronics	0.90		0.651	0.56		0.169	0.38	*	0.033	0.48		0.230
	Others	1.16		0.786	1.76		0.459	1.73		0.497	4.97		0.605
	Public Tech Institutions (Baseline=Private Tech Institution)	2.72	+	0.063	1.97		0.323	2.24		0.257	3.41		0.207
	Public Universities	0.90		0.692	0.77		0.465	0.84		0.650	0.74		0.569
	Private Universities	1.18		0.521	1.58		0.207	1.73		0.157	1.84		0.250
	Engineering and Technology (Baseline=Human Resources)	0.74		0.302	0.41		0.025	0.38	*	0.021	0.40		0.100
	Management and Finance	3.05	*	0.036	1.92		0.390	1.84		0.441	2.53		0.441
	Operations	1.44		0.147	1.04		0.921	1.06		0.875	1.38		0.517

Heteroske-dasticity	Gender											0.42	**	0.013
	cut1	-3.63	*	0.000	7.6	***	0.000	9.7	***	0.000		16.9	***	0.000
	cut2	-0.16		0.651	13.2	***	0.000	15.8	***	0.000		25.3	***	0.000
	Log Likelihood	-385			-218			-196				-161		
	Likelihood Ratio	24.6			333.9			45.9				6.2		
	p-value	0.038			0.000			0.000				0.013		
	Parameters	16			20			25				32		
	Akaike Information Criterion	803			477			441				386		

+ p < 0.1, * p < 0.05, ** p < 0.01, *** p < 0.001 * Model 4 corrected for Heteroskedasticity

In this nested series of models, the Akaike Information Criterion decreased from 803 for Model 1, to 386 for Model 4*. Model 4* passed the parallel lines assumption test, indicating a well-specified model.

2.9. Conclusions

The cognitive skills with positive effects on the Execution of main tasks were understanding needs for both internal and external clients (ß = 0.19, $p \leq 0.000$), planning and scheduling internship activities (ß=0.09, $p \leq 0.002$), practical ability to apply his/her technical competencies (ß=0.08, $p \leq 0.031$), good judgment to implement his/her ideas (ß=0.07, $p \leq 0.048$), and writing reports to share information with others (ß=0.12, $p \leq 0.001$). Proactivity to locate contacts that had relevant information had a negative effect on task execution (ß=-0.07, $p \leq 0.020$). Teamwork/collaboration measured by the ability to work with members in other areas had a significant and positive effect on the Execution of the tasks (ß=0.08, $p \leq 0.021$). An intrapersonal skill with significant and positive effects was the ability to work in ambiguous situations (ß=0.09, $p \leq 0.009$).

The best linear model for Learning new knowledge shows the following results: only two of six cognitive skills had significant and positive effects on Learning new knowledge, these were understanding needs of both internal and external clients (ß=0.29,

$p \leq 0.000$), and having good judgment to implement his/her ideas (ß=0.15, $p \leq 0.064$). No interpersonal skills were significant for the best linear model of Learning new knowledge. The intrapersonal skill, proactivity for his/her professional self-update had a significant and positive effect (ß=0.16, $p \leq 0.033$). Completing an internship during fall and spring academic periods instead of the summer period had a negative effect on internship learning ($ß_{fall}$=-0.63, $ß_{summer}$=-0.97, $p \leq 0.000$ for both fall and spring).

The best-ordered logistic model for Overall performance as an intern included four of six cognitive skills: understanding needs for both internal and external clients (Odds ratio=5.14, $p \leq 0.000$), planning and scheduling internship activities (Odds ratio=1.80, $p \leq 0.055$), practical ability to apply his/her technical competencies (Odds ratio=2.54, $p \leq 0.017$), and writing reports to share information with others (Odds ratio=4.01, $p \leq 0.000$). The model also included the interpersonal skill of teamwork/collaboration measured by the ability to work with members of other areas (Odds ratio=2.24, $p \leq 0.028$) and the intrapersonal skills measured by proactivity for his/her professional self-update (Odds ratio=2.22, $p \leq 0.028$). Completing the internship in fall and spring academic periods compared with summer had a negative effect on the overall performance as an intern.

Thus, different skills are associated with different measures of internship performance. Understanding needs of clients increased the effect on the three internship outcomes: Main tasks performance, Learning new knowledge, and Overall performance. Planning and organizing activities, practical ability to apply technical competencies, writing reports, collaboration, and work in ambiguous situations also increased the effect of Main tasks performance and Overall performance as an intern, but not to Main tasks

performance. Self-update contributed to enhance Learning new knowledge and Overall performance, but not to the execution of Main tasks. The whole set of cognitive skills enhanced Main tasks performance, but not for Learning new knowledge and Overall performance. Performing the internship in the summer was important to Learning new knowledge, but not to Main tasks and Overall performance.

2.10. Discussions

This study confirmed the theoretical notion stated by Goleman [54], Whetten & Cameron [55], and the Committee on the Assessment of 21st Century Skills of the NRC [18], that cognitive skills are necessary but not sufficient for success in executing complex professional tasks. Interpersonal and intrapersonal skills are needed as well.

All six hypotheses were found to be true for the internships represented in the database. Three cognitive skills, understanding the needs of internal and external clients (H1) planning and organizing abilities (H2), and practical ability to apply his/her technical competencies (H3) appeared in the models. The interpersonal skill of teamwork/collaboration (H4), and the intrapersonal skills of the ability to work in ambiguous situations (H6) and proactivity for her/his professional self-updating (H5) were also present.

In addition to confirming the theoretical relationships between skills and intern performance, this study revealed a practical and actionable option to improve internship performance. Performing an internship during the regular fall and spring academic semesters had a negative effect on Learning and Overall performance as an intern compared to internships completed in the summer. It is plausible that when interns are

distracted by coursework, their internship performance suffers. This result suggests that internships during the regular school year do not maximize the interns' potential for learning and professional performance.

2.11. Acknowledgements

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Chapter 3

3. What skills predict an intern's ability to innovate on the job? A quantitative study of innovation capability of Mexican college interns

Abstract

The ability to innovate is one of the most important and desired meta-skills for individuals, firms, and economies. Nurturing innovation capability will improve individual's employability and the ability to deal with a rapidly changing future. A recent conceptual model of individual's innovation capability, the D4 innovation model, has four stages: defining, discovering, developing, and demonstrating. This study analyzed performance evaluation data of interns at a multinational global steel company to develop an ordered logistic model addressing whether the four D innovation skills: defining, discovering, developing and deploying skills, predicted intern innovation capability. In addition to these innovation-related skills, we evaluated two other categories of employee attributes associated with innovation capability in the literature, foundation skills and professional competencies. Data were collected from summer 2006 to summer 2010, using a unique instrument to assess the interns' performance. The study confirmed that the innovation skills, discovery, developing and deploying, increase Individuals' Innovation

Capability. The foundation skills of oral communication and ability to self-update, and the professional competencies of establishing priorities and explicit knowledge also foster individual innovation capability.

" Today, the competition is keener; the challenge is tougher; and that is why innovation is more important than ever. It is the key to good, new jobs for the 21st century." Barak Obama [58]

3.1. Introduction

As the determinants of economic growth transition from raw materials to knowledge and innovation [59], innovation capability development at firm, state and national levels has become recognized as a critical component to sustainable or long-term economic growth [60]. Employees' capability to innovate is the building block for the knowledge economy.

Worker skills and innovation have been called the "twin engines of growth," [29] and college students identified as the major force of the future innovations [30]. Promoting innovation among workers requires an understanding of the antecedents of this quality, and a number of theoretical studies suggest a range of attributes of innovative people.

3.2. Theoretical Framework

3.2.1. Innovation Theory

Firm innovation capability is the ability to produce and commercialize new products, processes, and services demanded by the market, motivated by changing technologies and competition [60, 61]. Innovation has been defined as the commercial or industrial application of something new: a new product, process or method of production; a new market or sources of supply; a new form of commercial business or financial organization [62]. The Oslo Manual [19] and National Science Foundation [20] (NSF) have very similar definitions of innovation. They define innovation as the introduction or implementation of new or improved existing products, processes, organizational methods, marketing methods, workplace organization, or external relations. Other researchers define innovation as any market opportunity, policy, method or process, structure, or any product having some originality [63]. From the organizational point of view, innovation is "… the generation, development, and adoption of new ideas or behaviors. An innovation can be a new product or service, a new production process technology, a new structure or administrative system, or a new plan or program pertaining to organizational members." [21]

Innovation can be either incremental or radical. Incremental innovation is a solution within a technological paradigm that significantly improves the performance of a product, process, organizational methods, marketing methods, workplace organization, or external relations [64]. It is also described as improved current practices and provides essential changes in organizational practices [65]. Radical innovation has been defined as either exceptional performance attributes or performance significantly improved in attributes of a product, process or services or cost that challenge current markets or generate new ones [66].

3.2.2. Workplace Skills

In general, a skill is an individual capability for which there is a demand in the formal economy, which means in the labor market or entrepreneurial world. Workplace skill is defined as the capacity of a set of individual resources to perform some task or activity [67], and as "an ability or proficiency at a task that is normally acquired through education, training and/or experience," related to "competence, expertise, knowledge and human capital." [68] Tether et al. mentioned that the kinds of skills that foster innovation are "engineering, problem-solving, language skills, team working and communication skills." Individuals acquire skills to enable them to implement existing technologies and to assist them in developing novel products or in organizing work and production processes in improved ways [69].

The U.S. Department of Labor sponsored a study by the American Society for Training and Development to identify the essential skills employers want. The report found seven such skill categories [16].

1. **The Foundation:** Learning how to learn
2. **Basic Competencies Skills:** Reading, writing, and computation
3. **Communication Skills:** Speaking and listening effectively
4. **Adaptability Skills:** Solving problems and thinking creatively
5. **Developmental Skills:** Self-esteem, self-motivation, career development and goal setting.
6. **Group Effectiveness:** Interpersonal skills, teamwork, and negotiation
7. **Influencing Skills:** Understanding organizational culture, and sharing

leadership.

The U.S. Department of Labor Secretary's Commission on Achieving Necessary Skills (SCANS) lists three categories of foundation skills and five workplace competencies that all college graduates need to succeed in the workplace [17]:

Foundation Skills

1. **Basic Skills:** Reading, writing, arithmetic, listening and speaking
2. **Thinking Skills:** Creative thinking, decision making, problem solving, seeing things in the mind's eye, knowing how to learn, and reasoning
3. **Personal Qualities:** Responsibility, self-esteem, social, self-management and integrity/honesty.

Workplace Competencies

1. **Resources:** Allocates human resources, time, money, materials and facility resources
2. **Information:** Acquires and evaluates, organizes and maintains. Interprets and communicates, and uses computer to process information
3. **Interpersonal:** Participates as a member of a team, negotiates to arrive at a decision, works with cultural diversity, exercises leadership, teaches others, and serves clients/costumers
4. **Systems:** Understand-designs-improve systems, monitors and corrects performance
5. **Technology:** Selects technology, applies technology to task, maintains and troubleshoots technology.

3.2.3. Cultivating Innovation in Workers

There have been a number of qualitative analyses of the attributes required for cultivating innovation. Gregory listed the following creativity and innovation skills in engineering: recognition and formulation of problems, ability to use full range of engineering methods, consciousness of values and costs, appreciation of the process of innovation, understanding of human factors in engineering, critical point of view, and capacity for self-development [31]. The 3M-inventorpreneur's list of traits includes creativity, broad interests, problem solution, self-motivation, and resourcefulness [32].

In 2009 the National Endowment for Science, Technology and the Arts identified five innovative characteristics in young people, which they should develop or consolidate if they want to become future innovators [70].

1. **Creativity:** Imagination, connecting ideas, tackling and solving problems, curiosity.
2. **Self-efficacy:** Self-belief, self-assurance, self-awareness, feelings of empowerment, social confidence.
3. **Energy:** Drive, enthusiasm, motivation, hard work, persistence and commitment
4. **Risk-propensity:** A combination of risk tolerance and the ability to take calculated risks
5. **Leadership:** Vision and the ability to mobilize commitment.

The National Research Council's Committee on the Assessment of 21st Century Skills created a list of skills necessary for different types of employment, from high-wage

scientists and engineers to low-wage restaurant servers and elder caregivers [18].

1. **Cognitive Skills:** Non-routine problem solving, critical thinking, systems thinking, ICT literacy, creativity, and learning to learn/meta-cognitive skills.
2. **Interpersonal Skills:** Complex communication, social skills, teamwork/collaboration, social-cultural sensitivity, responsibility, tolerance for diversity, emotional/social intelligence, and leadership.
3. **Intrapersonal Skills:** Self-management, time management, self-development, self-regulation, adaptability, flexibility, executive functioning, core self-evaluation, work ethic, persistence, study skills, ethics & integrity, and citizenship.

3.2.4. Qualitative Models of Enhancing Innovation Skills

There is an emerging theoretical and empirical research movement in the field of innovation studies focused on identification, description, and categorization of skills required for innovation, and in the formation of innovation skills.

In 2008 Silverstein, Samuel, and DeCarlo proposed D4 Model for innovation [33] based on diverge and converge ideas [71]. It is a conceptual roadmap for the steps of innovation composed of 4 components:

1. **Define the Opportunity:** Divergently investigate many innovation opportunities and then analyze them to converge with a definition of an opportunity.
2. **Discover the Ideas:** The goal is to divergently propose as many options

as possible to refining innovation opportunity, explore all human knowledge and nature to resolve the redefined opportunity, in order to converge on the most adequate option in terms of predicted feasibility.

3. **Develop Designs:** Divergently create many different conceptual designs, then converge on the most feasible conceptual design, and validating and optimizing designs.
4. **Demonstrate Feasibility:** Exploit different ways for mapping new product and services delivery processes, for optimizing processes for efficient and flawless operations, and identifying potential problem prior to commercialization.

The current paper considers the preceding theories of employee qualities that improve innovation capacity and tests with an ordered logistic model. We construct a statistical model of individual innovation and fit it to data collected on personal attributes and workplace performance of college students participating in an internship program at a multinational steel company in Mexico.

3.3. The Mexican Policy Framework

3.3.1. Mexican National Program to Promote Innovation

In Mexico, the development of an innovative workforce is a national priority. A 2009 OECD report opined that since Mexico had moved slowly to a growth path driven by innovation, the Government of Mexico should create policies to improve individual, firm-level, and governmental capabilities to drive innovation [26, 27]. In 2011 the Mexican Secretary of Economy created the national innovation plan of Mexico. The plan

stated that innovation is a national priority, because only through it can the country increase the competitiveness of its economy and achieve growth rates and job quality that Mexico needs.

The plan has six pillars to promote innovation: 1) strengthening domestic and international markets, 2) generating knowledge with strategic vision, 3) strengthening business innovation, 4) financing innovation, 5) development of human capital of workers, students, employers, and educational institutions, and 6) defining the legal framework to nurture innovation. The objective of the fifth pillar, human capital development, is to increase the productive, creative and innovative contributions of individuals [28], because human capital is a fundamental requirement for innovation [72].

The Mexican National Council for Standardization and Certification of Labor Competencies (CONOCER) is the Mexican government entity that manages the National Competency System (NCS) to develop human capital to contribute to economic growth, educational development and social progress. In 2009, The NCS established the National Register of Competency Standards (RENEC). It catalogs all Mexican standards of competencies, in terms of a set of knowledge, skills and attitudes to perform job-related activities [73].

3.3.2. Internships and the Individual's Innovation Capability

In this paper we do not make any claims about the relationships between college internships and innovation capability. We merely use a rich database collected on the performance of students on internships to test theories of the relationship between personal skills and innovation capability. This database exists because a multinational

steel company has an internship program at the national level in Mexico in accordance with the Mexican Social Service Law and the Law of Professions [11,12].

3.4. Methods

3.4.1. The hypotheses of the study

The current study focuses on whether Silverstein *et al*.'s four D's: Defining, Discovering, Developing, and Demonstrating skills are important factors predicting the Individuals' Innovation Capability. Deploying and Demonstrating are considered to be equivalent in this study. Seven hypotheses were tested:

Table 3.1 List of hypotheses for Individuals' Innovation Capability

Number	Hypotheses
H1	Better **defining** ability enhances the Individuals' Innovation Capability.
H2	Better **discovering** ability enriches the Individuals' Innovation Capability.
H3	Better **developing** ability fosters Individuals' Innovation Capability.
H4	Better **deploying** ability improves Individuals' Innovation Capability.
H5	**Defining, discovering, developing, and deploying** skills working as set of innovation skills increase an Individuals' Innovation Capability.
H6	Better self-deployment improves an Individuals' Innovation Capability
H7	Better performance in collaboration enhances an Individuals' Innovation Capability

3.4.2. Modeling Individual Innovation Capability

Figure 3.1 is a diagram of the conceptual model that predicts Individuals' Innovation Capability as a function of foundation skills, professional competencies, and hypothesized innovation skills [18, 71] (the four D's). In addition to the four D's the model is used to evaluate some of the purported essential skills employers want [16],

Gregory's creative and innovative skills in engineering [31], 3M inventorpreneur traits [32], innovative characteristics of young people [70], and 21st Century skills [18]. The two main categories developed by the Secretary's Commission on Achieving Necessary Skills (SCANS) [17] guided the selection of relevant foundation skills and professional competencies. The model also included a number of control variables.

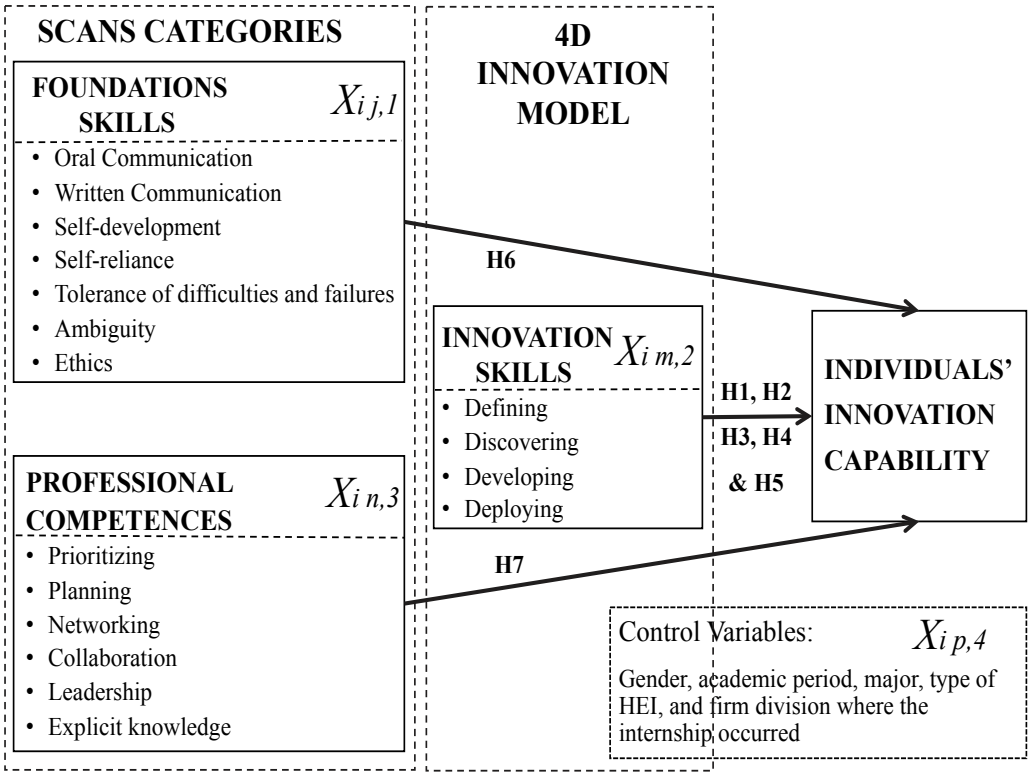

Figure 3.1. A conceptual model of Individual's Innovation Capability

3.4.3. Data Collection and Validation

The study population was composed of 500 interns who completed their first internship between summer 2006 and summer 2010. At the end of each completed internship, interns were evaluated by the firm mentor-tutor using a questionnaire that was developed by the firm to assess full time employees on professional expertise, business management, drive for results, client focus, interpersonal skills (teamwork,

communication, and leadership), and sharing knowledge (searching for information, using and applying knowledge, sharing knowledge, and mastering explicit knowledge). Questions were scored on a five-point Likert scale where: 5 = very good performance, 4 = good performance, 3= satisfactory performance, 2 = poor performance, and 1 = very poor performance.

Table 3.2 lists the 22 independent variables extracted from the internship reports (seven foundation skills, six professional competencies, four innovation skills, and five control variables) and presents descriptive statistics of the Individuals' Innovation Capability scores, the dependent variable (individual's innovation capacity), which was measured by the answer to the question on the internship evaluation reports, "Does the intern innovate and contribute with original ideas?"

The foundation skills included oral communication, written communication, self-development, self-reliance, tolerance of difficulties and failure, ambiguity, and ethics. The professional competencies were prioritizing, planning, networking, collaboration, leadership, and mastery of explicit knowledge. The innovation skills were defining, discovering, developing, and deploying. The control variables were gender, academic period, major, type of higher education institution (HEI), and firm division where the internship occurred. Originally 43 variables from the evaluation instrument were included, but only 22 remained after testing them for multicollinearity with individuals' innovation capacity and the explanatory variables (using the bivariate correlation, VIF and Tolerance Tests). A more detailed description of these data can be found in Galvan *et al.* [74]

For statistical reasons we collapsed responses collected with the 5-point Likert scale into three points: Below satisfactory performance, Satisfactory performance, and Above

satisfactory performance. We found it necessary to compact the five-point scale to a three-point scale for the ordered logistic regression model because of the small number of answers collected in the first and fifth level of the Likert scale. This allowed the study to meet the parallel lines assumption for individual's innovation capability.

3.4.1. Ordered Logistic Model Of Intern's Innovation Capability

The analysis was performed using ordered logistic regression.[2] Where y^*_i = the latent variable representing the interns' overall performance. X_1 to X_4 are matrixes of independent variables. The index for interns is i = [1, 2, … 500] and, ε_i are the error terms. The independent variables were categorized thus: foundation skills ($X_{ij,1}$), professional competencies ($X_{ij,2}$), innovation skills ($X_{ij,3}$), and control variables ($X_{ij,4}$).

$$y_i^* = \beta_0 + \boldsymbol{X}_{1ij}\,\beta_1 + \boldsymbol{X}_{2ij}\,\beta_2 + \boldsymbol{x}_{3ij}\,\beta_3 + \boldsymbol{x}_{4ij}\,\beta_4 + \varepsilon_i \qquad [3.1]$$

Equation 3.1 is similar to that for the binary regression model, except that there are now two cutpoints τ1, and τ2. The two cutpoints lead to three levels of interns' Overall performance (y_i), as showing below. The observed response categories are tied to the latent Individuals' Innovation Capability (y^*_i). For the ordered logistic regression, the cutpoints were estimated using the collapsed three-level Likert scale.

$$\boldsymbol{y_i} = \begin{cases} 1 \Rightarrow \text{Below Satisfactory Individuals' Innovation Capability} & \text{if } \tau_0 = -\infty \le \boldsymbol{y_i^*} < \tau_1 \\ 2 \Rightarrow \text{Satisfactory Individuals' Innovation Capability} & \text{if } \tau_1 \le \boldsymbol{y_i^*} < \tau_2 \\ 3 \Rightarrow \text{Above Satisfactory Individuals' Innovation Capability} & \text{if } \tau_2 \le \boldsymbol{y_i^*} < +\infty \end{cases}$$

The two cutpoints, τ_1 and τ_2, define the three levels of individual's innovation capability

[2] StataCorp. 2012. *Stata Statistical Software: Release 12*. College Station, TX: StataCorp LP.

(y_i), as shown above.

Table 3.2 Average internship skill scores and control variable values by Individuals' Innovation Capability

Independent Variables		Dependent Variable					
		Individual's Innovation Capability					
SCAN Category and 4Ds	Skills and Attributes assessed by the firm Variables *(j)*	Unsatis-factory n=48		Satisfactory n=217		Above Satisfactory n=235	
		Mean	*sd*	*Mean*	*sd*	*Mean*	*sd*
Foundation Skills (x_{1ij})	Expresses his/her ideas clearly and with confidence	2.63	0.76	3.26	0.54	3.99	0.72
	Writes reports to share information	2.96	0.87	3.41	0.64	4.17	0.74
	Proactive in his/her professional self-update	2.85	0.80	3.38	0.61	4.14	0.69
	Seeks feedback	2.60	0.90	3.40	0.70	4.00	0.80
	Tolerates frustration due to difficulties and failures	2.83	0.88	3.28	0.63	4.03	0.70
	Works in ambiguous situations	2.67	0.75	3.24	0.58	4.03	0.74
	Recognizes and appraises contributions from others	3.06	0.81	3.39	0.59	4.21	0.74
Professional Competencies (x_{2ij})	Establishes priorities and reports achieved results on time	3.20	2.42	3.25	0.61	4.07	0.73
	Planning and scheduling his/her activities	2.79	0.80	3.33	0.67	4.03	0.74
	Utilizes various ways to network building	2.85	0.74	3.26	0.58	4.03	0.71
	Works with members of other sectors	2.83	0.83	3.38	0.64	4.13	0.75
	Has ability to coordinate group tasks	2.69	0.72	3.20	0.60	3.97	0.78
	Inventories best practices for his/her project	2.42	0.74	3.03	0.56	3.76	0.77
Innovation Skills (x_{3ij})	Understands needs of internal and external clients	2.92	0.82	3.29	0.59	4.08	0.71
	Proactive to locate contacts who have relevant information	2.79	0.90	3.28	0.66	4.08	0.68
	Practical ability to apply his/her Professional Competences	3.00	0.55	3.39	0.60	4.17	0.62
	Good judgment to implement his/her ideas	2.81	0.70	3.32	0.56	4.14	0.68
Control Variables		***Freq***	***%***	***Freq***	***%***	***Freq***	***%***
Control Variables (x_{4ij})	Male	26	5.2	122	24.4	162	32.4
	Female	22	4.4	95	19.0	73	14.6
	Summer	12	2.4	63	12.6	79	15.8
	Fall	15	3.0	62	12.4	49	9.8
	Spring	21	4.2	92	18.4	107	21.4
	Industrial	16	3.2	74	14.8	79	15.8
	Chemical	6	1.2	30	6.0	26	5.2
	Materials and Mechanical	15	3.0	53	10.6	59	11.8
	Business	7	1.4	25	5.0	18	3.6
	Electronics	4	0.8	26	5.2	47	9.4
	Others	0	0.0	9	1.8	6	1.2
	Private Technological Institutions	15	3.0	59	11.8	83	16.6
	Public Technological Institutions	0	0.0	13	2.6	13	2.6
	Public Universities	24	4.8	89	17.8	205	41.0
	Private Universities	9	1.8	56	11.2	112	22.4
	Human resources	23	4.6	89	17.8	73	14.6
	Engineering and Technology	8	1.6	42	8.4	32	6.4
	Management and Finance	3	0.6	11	2.2	14	2.8
	Operations	14	2.8	75	15.0	116	23.2

3.4.2. Data Evaluation

Multicollinearity testing of all dependent and independent variables included the bivariate correlation test, the tolerance test (T), and the variation inflation factor test (VIF). A value of $T<0.1$ or a value of $VIF>10$ means that there is a collinearity problem. Independent variables having bivariate correlations greater than 70% with any of the other variables were dropped from the database. After removing those variables, $T>0.29$, $VIF<3.44$ and the mean VIF was 2.28, showing no multicollinearity problems in the data. Table 1 shows the remaining 22 explanatory variables.

In addition to the multicollinearity tests, the Cronbach's alpha test was used to evaluate the internal consistency of mentors-tutors (respondents). The alpha for foundation skills was 0.93; for professional competencies, 0.90; for innovation skills, 0.88; and the global alpha was 0.97.

3.5. Results

Table 3.3 shows the four ordered logistic models for Individuals' Innovation Capability measured with the innovation and original contributions of the intern. Each previous model is nested in the subsequent model. Model 1 only includes the control variables. Model 2 has the foundation skills and the control variables. Model 3 included the control variables, foundation skills, and professional competencies. Model 4 included the control variables, foundation skills, and professional competencies, and the innovation skills.

The homoscedastic residuals assumption was not met for Model 4, when each

variable was tested for heteroskedasticity.[3] The variable that presented heteroskedastic problems was Discovering. The new best model is the Model 4 corrected for heteroskedasticity. It achieved significance with LL=-283.67, LR=21.38, p = 0.000, and AIC=635 versus the previous version of Best Model whose AIC = 651. The best ordered logistic model of intern innovation capability met the parallel lines assumption, indicating a well-specified model.

Table 3.3 Ordered Logistic Models for Individuals' Innovation Capability

Com-ponent	Variable in the model	Skill assessed by the firm	Model 1			Model 2			Model 3			Model 4*		
			OR		p	OR		p	OR		p	OR		p
Innova-tion Skills	Defining	Understands needs of internal and external clients										1.4		0.539
	Discovering	Proactivity to locate contacts who has relevant info.										3.3	+	0.089
	Developing	Practical ability to apply his/her technical competences										3.6	*	0.049
	Deploying	Good judgment to implement his/her ideas										2.9	+	0.096
Professio nal Compe-tences	Prioritizing	Establishes priorities and reports achieved results on time							1.9	**	0.004	2.9	+	0.079
	Planning	Planning and scheduling internship activities							1.3		0.214	1.1		0.794
	Networking	Utilizes various ways to build a network							1.2		0.385	1.0		0.995
	Collaboration	Works with members of other areas							1.1		0.716	0.9		0.839
	Leadership	Ability to coordinate tasks in a group							1.2		0.347	1.4		0.517
	Explicit Knowledge	Inventories best practices for his/her project							1.8	*	0.016	2.7	+	0.096
Founda-tion Skills	Oral Communication	Expresses his/her ideas clearly and with confidence				2.5	***	0.000	2.0	**	0.003	3.6	+	0.056
	Written communication	Writing reports to share information				1.1		0.692	0.8		0.199	0.5		0.185
	Self-development	Proactivity in his/her professional self-update				2.6	***	0.000	2.2	***	0.000	5.3	*	0.028
	Self-reliance	Seeks for feedback				1.4	*	0.060	1.2		0.434	1.4		0.425
	Tolerance for stress	Tolerates frustration due to difficulties and failures				1.1		0.724	1.0		0.948	0.7		0.577
	Adaptability	Works in ambiguous situations				2.0	**	0.001	1.4		0.109	2.0		0.237
	Ethics	Recognizing and appraising contributions from others				1.1		0.533	0.9		0.814	0.8		0.730
Control Varia-bles	Gender	Female *(Baseline=male)*	0.7	+	0.071	0.7		0.122	0.7		0.110	0.4		0.176
	Academic Period	Fall	0.7		0.236	0.5	**	0.023	0.5	+	0.071	0.2	+	0.088
		Spring	0.8		0.431	0.5	**	0.021	0.6	+	0.093	0.2		0.100
	Major	Chemical *(Baseline=industrial)*	0.8		0.587	1.2		0.677	1.2		0.592	1.5		0.643
		Materials and Mechanical	0.8		0.420	1.0		0.865	1.2		0.634	1.4		0.608
		Business	0.6		0.112	0.7		0.499	1.0		0.954	0.8		0.796
		Electronics	1.5		0.156	1.7		0.165	1.7		0.162	3.6		0.203
		Others	1.3		0.657	1.8		0.386	2.2		0.251	6.9		0.237
	Type HEI	Public Tech Institutions *(Baseline=Private Tech Institution)*	1.8		0.211	1.9		0.225	1.9		0.257	7.5		0.194

[3] Ordinal Generalized Linear Models STATA command oglm.

		Public Universities	1.2		0.449	1.4		0.275	1.2		0.507	2.1		0.336
		Private Universities	0.8		0.276	0.8		0.441	0.7		0.360	0.4		0.282
	Firm Division	Engineering and Technology *(Baseline=Human Resources)*	1.0		0.944	0.9		0.728	1.0		0.954	1.4		0.689
		Management and Finance	2.4	+	0.082	1.3		0.620	1.3		0.664	4.4		0.357
		Operations	1.9	**	0.008	1.5		0.167	1.8	+	0.075	3.1		0.142
Heteroskedasticity		Gender										0.2	*	0.011
		cut1	-2.3	***	0.000	7.7	***	0.000	9.0	***	0.000	23.4	**	0.004
		cut2	0.1		0.690	11.4	***	0.000	12.9	***	0.000	32.2	**	0.003
		Log Likelihood	-455			-310			-296			-284		
		Likelihood Ratio	32			290			27			31		
		p-value	0.004			0.000			0.000			0.000		
		Parameters	16			23			29			34		
		Akaike Information Criterion	942			666			651			635		

+ p < 0.1, * p < 0.05, ** p < 0.01, *** p < 0.001 * Model 4 corrected for Heteroskedasticity

Oral communication measured as the ability to express his/her ideas clearly and with confidence (Odds ratio (OR)= 3.6, p=0.056), and the willingness for self-development assessed with the proactivity in his/her professional self-update (Odds ratio= 5.3, p=0.028) as foundation skills, had significant and positive effect on Individuals' Innovation Capability. Professional competencies with moderately significance and positive effect were the ability to establish priorities and achieve results on time (Odds ratio= 2.9, p=0.079) and the ability to inventory best practices for his/her project as a proxy measurement for explicit knowledge (Odds ratio= 2.7, p=0.096).

Table 3.4 shows the summary of hypotheses for Individuals' Innovation Capability. The study revealed that hypothesis, H1, that the ability to define opportunities enhances the Individuals' Innovation Capability, was not found to be true (p=0.539). H2, that the ability to discover ideas enriches innovation capability, was true (p=0.038). H3, that the ability to develop designs fosters Individuals' Innovation Capability, was true (p=0.049). H4, that the ability to deploy an idea improves innovation capability, was true (p=0.096). H5 tested the set of the innovation skills together, but was not found to be true (p=0.201).

H6, that better self-development improves Individuals' Innovation Capability, was

found to be true. Also proactivity of the interns for his/her professional self-update had a positive effect on Individuals' Innovation Capability (p=0.028). H7, that better performance in collaboration enhances Individuals' Innovation Capability, was not found to be true (p=0.839).

Table 3.4 Summary of hypotheses for Individual's Innovation Capability

Hypothesis	Factor enhancing Individuals' Innovation Capability	Wald test (χ2, p-value)	True / No found to be
H1	Defining	(χ2=0.38, p=0.539)	No found to be
H2	Discovering	(χ2=6.54, p=0.038)	True
H3	Developing	(χ2=3.88, p=0.049)	True
H4	Deploying	(χ2=2.77, p=0.096)	True*
H5	All four D's working together	(χ2=7.28, p=0.201)	No found to be
H6	Self-development	(χ2=4.84, p=0.028)	True
H7	Collaboration	(χ2=0.04, p=0.839)	No found to be

* A hypothesis test was considered significant at the $p \leq 0.10$ level in this report.

Table 3.5 shows the summary of different variations of Hypothesis 5. Groups of two and three D4 skills were tested together. Innovation skills defining, discovering, developing, and deploying working together did not reach significance. The pair of defining and discovering working together was significant on Individuals' Innovation Capability (p=0.086). The pair of discovering and developing working together was significant on Individuals' Innovation Capability (p=0.071). The pair of discovering and deploying working together was significant on Individuals' Innovation Capability (p=0.085). The pair of developing and deploying working together was significant on Individuals' Innovation Capability (p=0.060).

Table 3.5. Summary of different options of hypothesis 5 for Individual's Innovation Capability

Hypothesis H5	Factor enhancing Individuals' Innovation Capability	Wald test (χ2, p-value)	True / No found to be true

H5a	Defining, discovering, developing	($\chi2$=7.11, p=0.130)	No found to be true
H5b	Defining, discovering, deploying	($\chi2$=6.67, p=0.154)	No found to be true
H5c	Defining, developing, deploying	($\chi2$=5.84, p=0.112)	No found to be true
H5d	Discovering, developing, deploying	($\chi2$=7.20, p=0.126)	No found to be true
H5e	Defining, discovering	($\chi2$=6.59, p=0.086)	True*
H5f	Defining, developing	($\chi2$=4.28, p=0.118)	No found to be true
H5g	Defining, deploying	($\chi2$=2.94, p=0.230)	No found to be true
H5h	Discovering, developing	($\chi2$=7.03, p=0.071)	True*
H5i	Discovering, deploying	($\chi2$=6.63, p=0.085)	True*
H5j	Developing, deploying	($\chi2$=5.61, p=0.060)	True*

* A hypothesis test was considered significant at the $p \leq 0.10$ level in this report.

3.6. Discussion

Four of seven hypotheses were found true (H2, H3, H4 and H6) at the $p \leq 0.10$ level. The intern's discovering ideas (H2), developing designs (H3), deploying ideas (H4) and ability to self-update (H6), when tested alone had positive effects on Individuals' Innovation Capability.

Several pairs of innovation skills working together had positive and significant impacts on an Individuals' Innovation Capability (H5):

a. Defining and discovering

b. Discovering and developing

c. Discovering and deploying

d. Developing and deploying

Thus, the study partially confirmed the four D's of the 4D innovation model [24] and completely the three D's of the framework on innovative engineering [26] though not in the expected way, because only H2 (Discovering) and H3 (Developing) were highly significant. H4 (Deploying) was significant at the $p \leq 0.10$ level, and H1 (Defining opportunities) was not significant in predicting Individuals' Innovation Capability. The

all D`s working together did not make a convincing model, though some pairs of these skills did. One interpretation of these findings is that, while the identified skills are indeed important, however, the variations among interns meant that not all innovation skills were relevant to the innovation capacity of all interns. Considering this variability, a larger data set would help clarify the statistical significance of the models.

Collaboration was found to have insignificant effect on Individuals' Innovation Capability. Romijn and Albaladejo found that collaboration at firm level was important for firm innovation capability [75]. These results are not contradictory with ours, as they are measuring a distinct phenomenon. Interns are often assigned well-defined tasks that can be accomplished in a limited amount of time that may not require collaboration. Full-time employees will have more complex tasks and different collaboration needs. Performing an internship during the summer had a positive effect on the individual's innovation capability, as in Galvan *et al*. [74] A possible explanation is that students can spend more time on the internship in the summer when they do not have classes. In light of this finding, firms and universities might consider scheduling the most complex and interesting internships in summer or invite students from taking internships during the regular school year.

These empirical results of this study focus attention on the personal qualities that had impact on workforce innovation capacity, which may be relevant in the design of programs to foster innovation. In the Mexican context, these results would support efforts by the National Register of Competency Standards to develop educational standards for Discovering, Developing and Deploying skills to foster students' innovation capabilities. This action could contribute to the Fifth (Development of productive, creative and

innovative skills) and the Sixth pillars (legal framework to nurture innovation) of the Mexican Innovation Plan.

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Chapter 4

4. Assessing the impact of mandatory internships on employability of recent college graduates in Mexico

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Abstract

Internships have been required for graduation by institutions of higher education because internships are perceived to help students increase their employability as well as provide educational value. This paper focuses on whether students' performance as interns and the number of internships they completed are significant in determining their employability in various labor-market conditions. The study analyzed the records of 1,184 graduates at a private Mexican university who had completed undergraduate degrees in business, design, and engineering as well as mandatory internships between 2006 and 2009. A logistic regression model for job placement four months following graduation included: individual factors, personal circumstances, external conditions, and interactions with external conditions. Variables found to have a positive impact and a strong significance ($p \leq 0.05$) on the Probability of Employment (in order of decreasing influence) were: an excellent performance as an intern, a high degree of social connections, and high admission test score. Moderately significant variables ($p \leq 0.10$)

were: students' having graduated from the engineering school, labor-market conditions during the job search, a good performance as an intern, and being male. Variables with a negative impact on employability and a strong significance on employment were the interaction between students having graduated from the engineering and technology majors and their performance as an intern. Moderately significant variables were the interaction between labor-market conditions and how early graduates began their first internship. This study revealed that the performance as an intern played an important role on employment and that employability depended on the interaction of a graduate's personal assets, his/her family connections, and whether or not the labor market was contracting.

4.1. Introduction

Over the last century, the concept of employability has been changing from a static binary dimension defined as being qualified for a job or not to a more dynamic and complex notion of employability as an interactive and adaptive ability to obtain meaningful jobs throughout an individual's lifetime. The contemporary definition of employability is associated with a group of personal assets (knowledge, technical competences, parental circumstances, among others) that help college graduates face the changing labor market conditions and obtain employment. In this sense, employability is a relative capacity of individuals to obtain and retain employment and adapt their assets for new employment opportunities. In response to this change, higher education institutions (HEI) have been adapting their curricula to foster characteristics of employability in their graduates. One such adaptation is an increased emphasis on

experience-based learning through learning service, co-op programs, off-campus internships, practicums, and job experience activities.

Previous studies have reported that students received added value from experience-based learning activities such as internships, field experience, and practicum among others. Internships have been said to improve or develop characteristics looked-for by employers: essential skills and attributes [1-3], personal competencies [4, 5], transferable skills [1, 3, 5-8], job qualifications [2, 3], work knowledge [4, 9], professional development [2], and adaptability and mobility to a new position [2, 5, 9, 10].

Most of the studies noted above compared a group of students who had an internship experience with a group who had none. However, Scholz used pre and post internship questionnaires, to assess the influence of mandatory internships on scientific knowledge, general abilities, key qualifications, problem-solving ability, and aptitudes [5].

As mentioned, internships foster in students the desired employment characteristics and help them obtain their first job after graduation [1, 6, 9]. The current study attempts to determine, for mandatory internships, whether the student's performance as an intern and the amount of internship experience are important factors in determining employment after graduation. In general, the logistic model for the Probability of Employment within four months after graduation included recent graduates' characteristics, recent graduates' personal circumstances, conditions of the labor market, and the interactions between these factors.

4.2. Changing Notions of Employability

Gazier identified three stages of the evolution of employability: first, a binary notion

of employability defined as simply the ability to be employed; second, a moderately interactive concept in which employability was defined as the ability to obtain and retain employment; and finally, an adaptive and interactive notion. Gazier suggests that individuals should show the ability to adapt skills, attributes and knowledge for future employment opportunities [34, 76].

Based on the dynamic notion of employability of Hillage and Pollard [77], McQuaid and Lindsay [35] synthetized a definition that includes three components: (a) individual factors which are assets such as knowledge, skills, and specific experiences; (b) personal circumstances such as socio-economic status, networking, and individual's household conditions; and (c) external context factors related to labor market conditions, employment regulations, and the effectiveness of the job matching process.

Yorke defined employability as a probabilistic process, citing the following "a set of achievement–skills, understandings and personal attributes– that makes graduates more likely to gain employment and be successful in their chosen occupations, which benefits themselves, the workforce, the community and the economy" [36]. The uncertainty generated by contextual forces interacting with their individual factors and personal circumstances could affect a person's chance of obtaining employment, even if the individual precisely meets the desired attributes of employers.

4.3. Employability and the Academic Curriculum

One of the most important functions of HEIs is providing highly qualified human capital to the labor market. HEIs are using different academic models to better integrate curricular and extracurricular activities as formal actions to develop the student's

employability. The “spiral model for competency formation” presented in 2007 by Walther and Radcliffe includes five curricular components: (1) learning activities, (2) other curricular elements, (3) student attitude, (4) extra-curricular activities, and (5) meta-influences [78]. It is worth mentioning that the “spiral model for competency formation” captures the entire curricular model with regard to the study context. The major goal of each curricular component is to enhance students’ employability characteristics to help students better face changing labor market conditions. The fourth component includes *Internships* that provide students with real-world experience in organizations and the opportunity to apply and develop their knowledge, skills and attributes while functioning as a professional [1- 5]. An internship typically involves three parties: the HEI, the student-intern, and the organization.

Internships are generally considered a curricular complement that engages students in learning about their professional field and provides them with real-world challenges. Internships also enable students to observe professional techniques and problems not contemplated in the classroom, giving them a better understanding of the business world [4].

There are several ways to foster students’ employability via a HEI´s curriculum. One way is through experience-based learning, which requires students to use their experiences, capacities, previous knowledge, personal skills, and personal attributes to solve a problem [79]. In 2010, Lichtenstein used data from the National Survey of Student Engagement (NSSE), based on responses from seniors in U.S. universities, to show the growing use of experience-based learning activities including internships, or similar learning activities. Nearly 86% of engineering seniors and social science seniors

reported participating in such activities. The percentage was 82% for business seniors and 75% for humanities seniors. These percentages show the high interest of American universities in offering experience-based learning and students' interest in obtaining such real-world experience to enrich their employability [13].

4.4. Legal Framework of Internships in Mexico

Mexican college students must participate in a mandatory internship program established by Mexican Law [11, 12]. The Mexican Constitution and under related laws and regulations for obtaining a higher education degree mandates Social Service by college students [12]. The Social Service is implemented under two approaches: (a) socially-oriented experience, and (b) professionally-oriented experience – the internship. Internships are not mandatory in the Mexican higher education system; each HEI Institution is responsible of its inclusion of the curricular program, but the vast majority of Mexican universities allow the internship option. An internship program is permitted for a regular student who has completed at least seventy percent of the academic program and has a QPA above of 70 of 100; a professional accredited under the Mexican Law of Professions must advise the intern. Most universities consider internships a valid way to meet the students' social service requirement mandated by The Mexican Constitution [11], and related laws and regulations. The Law of Professions states that the Department of Education must authorize each internship program [12].

Several Mexican HEIs have instituted internships as mandatory parts of curricula, in addition to the federal requirement of Social Service. In 1993, the Mexican National Public System of Technological Institutes (NPSTI) established the first mandatory

national internship policy, in addition to Social Service, as an obligatory curricular activity [80]. The NPSTI's policy states that students must do at least one internship. Since 1990 internships have been mandatory in the university where the present study was carried out [81]. The University's policy allows its various academic programs to set their own requirements for the total number of internship credits (within a range of 12-24 credits). An internship has a specific objective; for example, a mechanical engineer could do internships in product development, product engineering, or manufacturing processes. Students can perform internships in the last one-and-a-half years of their academic program. In both the university under study and NPSTI systems, students are advised by an industry coach and an academic-advisor, have a well-defined project, have their performance assessed, and create a technical report. Students receive help finding an internship mainly from the academic program director, the department chairman, an internship advisor, or the university's Career Center; however, some of the students use their personal networks to find one.

4.5. Previous Studies on the Benefits of Student Internships

Students improve their *academic performance* [1, 2, 8, 82] and come back to the university after an internship with more motivation [4]. Narayanan states students consider internships as one of the most important curricular experiences to learn about occupational environments [83]. Internships also provide real-life professional experience [3, 8, 9, 84].

Previous studies have shown that internships foster employability characteristics: essential attributes such as self-discipline [1], positive attitude and performance at work

[3], and ability to reconcile conflicts of interest [2]. Studies have also showed an association with personal competences such as motivation [4] and autonomy [5]. Many previous studies have focused on the assessment of transferable skills. Bridges defined transferable skills as easily adaptable skills to re-use in different social or professional situations [85]. Transferable skills include communication [5-8]; oral presentations and computer skills [6]; research skills and critical thinking [7]; creative thinking [6, 7]; time management [1]; report writing, problem-solving abilities, and organization of work [5]; and attitude to improve the status quo [3]. Besides increasing students' knowledge, skills, and attributes, internships provide them with better job qualifications, professional training for specific jobs [3], and better ability to deal with ambiguous situations [5].

Internships nurture in students the characteristics desired by employers. This increases the likelihood of obtaining the *first job after graduation* [1, 6, 9]. Students are also better equipped to evaluate and accept job opportunities [3, 9] as a result of socialization and acculturation gained during the internship [10]. In regards to *job performance*, Blair, Gault, Leach Duey, and Taylor have found that internships promote a better starting salary [3, 6, 82], better current salary [6], better job satisfaction [3], and higher promotion rates [2]. However Knouse, Tanner, and Harris mentioned that there is only a limited window of time (6 months) following graduation during which students who are looking for a job and who did an internship have an advantage over students who did not [1].

4.6. Research Question and Hypotheses

Employability and employment are not the same but depend on each other.

Employability is a group of characteristics that a recent graduate possesses that is necessary but not sufficient to gain employment [35]; external conditions in the labor market also play an important role [34, 35, 76, 79].

This study addresses the research questions whether students' performance as interns and the number of internships they completed are significant in determining their employment in various labor-market conditions. Figure 4.1 shows a model to predict student employment within four months of graduation. It was built combining dimensions of various definitions of employability, as a probabilistic process [36]; as having three components: individual factors, personal circumstances, and external conditions [35]; as a dynamic concept [76, 77] and an interactive and adaptive notion [34, 76].

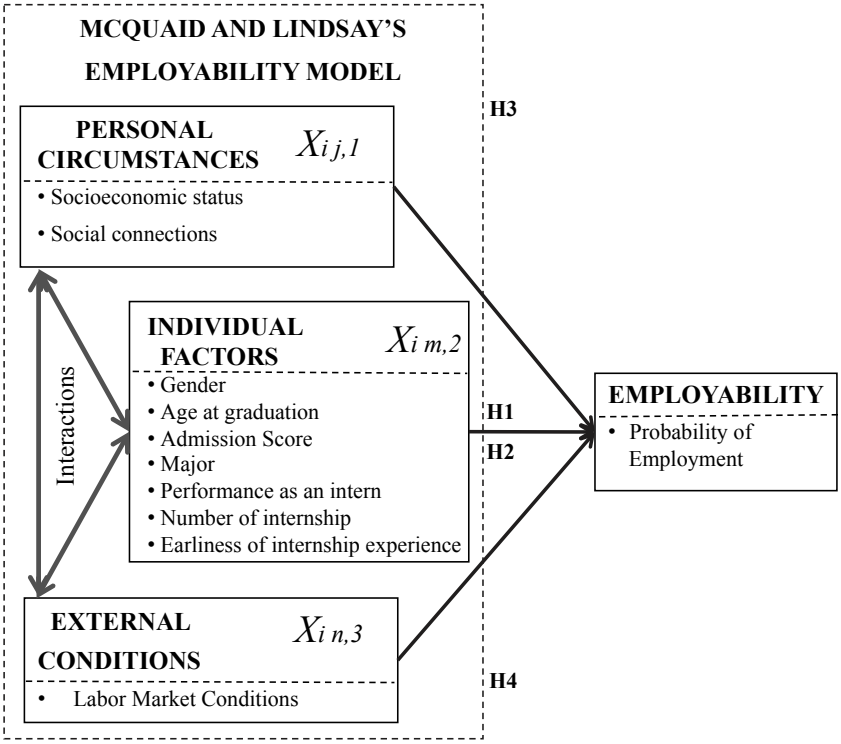

Figure 4.1 A conceptual model of Probability of Employment

A logistic model was used to estimate the Probability of Employment of recent

graduates, where one equal employed and zero otherwise. Table 4.1 shows the hypotheses of the model:

Table 4.1 List of hypotheses for recent graduate's employment

Number	Hypotheses
H1	Better performance as an intern increases the recent graduate's likelihood of employment in the first four months following graduation.
H2	A greater number of internships during college increase the recent graduate's Probability of Employment in the first four months following graduation.
H3	Higher socio-economic status and wider social connections improve an individual's Probability of Employment in the first four months following graduation.
H4	Labor-market conditions strongly affect the Probability of Employment for recent graduates.

In addition, the study considered control variables such as graduates' gender, age at graduation, admission score (SAT), academic performance (QPA), earliness of students' internship experience, and graduates' major. The dynamic and interactive notion of employability was modeled using the graduation years (GY) to capture the changing external conditions in the labor market during job search.

4.7. Data

The study population was a cohort of 1,184 recent graduates at a private Mexican university who had completed their undergraduate degrees in engineering, business, or architecture and design between 2006 and 2009. The observational unit was a recent graduate from these schools.

The dependent and independent variables were collected from five university databases. The Alumni Relations Center of this university routinely conducts two periodic surveys: (a) an exit survey for graduating students (96% response rate),

administered one month before graduation, which includes questions about students' perception of curricular components and employability elements; and (b) the employment survey (92% response rate), which is a stratified random sample (by majors) for recent graduates administered within four months of graduation.

Together, these two surveys provide information about whether recent graduates are employed or not, their starting salary, and how long they were unemployed prior to placement. In addition the data included the graduate's gender, number of credits earned, grades obtained in each internship, quality point average, the number of months between the first day of a student's internship and his/her graduation, the students' admission scores, high school affiliation, and parents' hometown.

The high school affiliation was used as a proxy variable of socio-economic status (SES). If recent graduates attended a private high school then the level of SES was assigned as high, and public high school as low socio-economic status. The location of the parents' hometown was used as a proxy of family social connections (SC). If the student´s parents live in the same town as the university then the degree of SC was assigned as high, and if the parents' hometown was not local, then the degree of SC was as low. After graduation, most of the students seek employment in the town where the university is located. Students whose parents resided in the same town as their university were considered to be better socially networked than students whose parents lived elsewhere**.**

4.8. Explanatory Data Analysis and Coding Variables

This section shows how each independent variable was classified, and coded. Table

4.2 shows the variable names and codes for the dependent variables and each independent variable as well as numbers of students represented in the dataset. Overall, the database included 1184 graduates from 2006 to 2009: 279 graduates in engineering and technology, 589 in business, and 316 in architecture and design. The overall percentage of employed students within four months of graduation for the four classes of recent graduates was 77%.

The three variables associated with internships are student's performance as an intern (SPI), number of completed internships (NCI), and the earliness of student's internship experience (Earliness). Table 4.2 shows the descriptive statistics of these variables. The students' performance as an intern was evaluated by assigning one of four levels of performance, excellent, good, satisfactory or poor, based on his/her average performance as an intern. The amount of internship experience was measured with the number of internships completed during the academic program. The earliness of student's internship experience was measured based on the remaining number of months from the student's first day as an intern to his/her graduation. The time to start internships, according with the university policy is in the last one-and-a-half years of the academic program.

The mean for the student's performance as an intern was 93 out of 100 points, standard deviation was 6.0, with a minimum of 72 of 100. Four hundred thirty six new alumni had obtained an internship performance rating of excellent, and 83% of them were employed four months post graduation. Three hundred seventy six recent graduates had obtained an internship performance rating of good, and 75% of these graduates were employed. Finally, 372 recent graduates obtained performance ratings of satisfactory or poor, and 72% of them were employed. Five hundred forty five recent graduates had

done 3 internships, and 76% of them were employed; 639 recent graduates had done 2 internships and 79% of them were employed. The earliness of internship experience was measured in months from the first day as an intern to graduation day. The mean was 17 months, approximately one-and-a-half years, consistent with the university's policy. The standard deviation was 6 months, a minimum of 4 months, and a maximum of 58 months. The mean internship earliness of recent graduates who were employed was 15 months and the mean of unemployed was 17 months.

As mentioned above the study used other individual factors as control variables. Table 4.2 shows their descriptive statistics. The employment figures for recent graduates from the various schools were as follows: engineering and technology: 77%, architecture and design: 81%, and business: 75%. The mean of the admission scores (SAT), was 1,232 points, the standard deviation was 117 points, and the range was 978 to 1,534.

The mean SAT of recent graduates who were employed was 1,238 points and the mean of unemployed was 1,209 points. The mean of quality points average of the students was 87 of 100 points, the standard deviation was 7, and the range was 70 to 99. The mean QPA of recent graduates who were employed was 87 points, and the mean of unemployed graduates was 86 points.

In regard to the variables of personal circumstances, in Mexico, there are two commonly accepted measurements for the students' socio-economic status: the Mexican National Survey of Income and Consumption and the scale created by the Mexican Association of Market Research Agencies and Public Opinion. Using these two pieces of information and the parents' address, one can approximate the socio-economic status for each new graduate. However, because the parents' addresses were considered

confidential information, a proxy variable for socio-economic status was created by using the student's high school affiliation, public being presumed to correlate with low socio-economic status and private being presumed to correlate with high socio-economic status.

Table 4.2 Dependent and independent variables: names, descriptive statistics, and coding

Independent Variables		Level	Dependent Variable		Total	Coding, states of the variables (0=Baseline)
			Employed	Unemployed		
Individual factors	Student's Performance as an intern Mean=93 points Std Dev = 6 points	Excellent (Points > 95)	361 (83%)	75 (17%)	436 (37%)	2=Excellent
		Good (90 < Points <= 95)	282 (75%)	94 (25%)	376 (32%)	1=Good
		Satisfactory (85 < Points <= 90)	147 (71%)	59 (29%)	206 (17%)	0=Satisfactory or poor
		Poor (Points <= 85)	122 (74%)	44 (26%)	166 (14%)	
	Number of completed internships	Three Internships	412 (76%)	133 (24%)	545 (46%)	1= 3 internships
		Two Internships	500 (79%)	139 (21%)	639 (54%)	0= 2 internships
	Earliness of student's internship experience	Continuous variable (months)	Mean=15.5 Std Dev=6.0	Mean=17.0 Std Dev=6.5	Mean=16.6 Std Dev=6.2 Min=4, Max 58	No baseline
	Gender	Male	350 (79%)	91 (21%)	441 (37%)	1= Male
		Female	562 (76%)	181 (24%)	743 (63%)	0= Female
	Age at graduation	Continuous variable (years)	Mean=23.4 Std Dev=1.1	Mean=23.5 Std Dev=1.2	Mean=23.4 Std Dev=1.1	No baseline
	Admission score	Continuous variable (points)	Mean=1238 Std Dev=116	Mean=1209 Std Dev=120	Mean=1232 Std Dev=117	No baseline
	Academic performance	Continuous variable (points)	Mean=87.0 Std Dev=5.7	Mean=85.8 Std Dev=5.4	Mean=86.7 Std Dev=5.6 Min=70, Max=99	No baseline
	Major	Eng. and Tech.	214 (77%)	65 (23%)	279 (24%)	2= Eng. & Tech.
		Arch. and design	255 (81%)	61 (19%)	316 (27%)	1= Arch & Design
		Business	443 (75%)	146 (25%)	589 (49%)	0=Business
Personal circumstances	Private or Public High school as a proxy of SES	Private high school	835 (78%)	240 (22%)	1075 (91%)	1= High SES
		Public high school	77 (71%)	32 (29%)	109 (9%)	0=Low SES
	Parents' hometown as a proxy variable of Social Connectedness.	Parents' hometown same as university town	645 (80%)	165 (20%)	810 (68%)	1=High-social connections
		Parents' hometown different than university town	267 (71%)	107 (29%)	374 (32%)	0= Low-social connections
External conditions	Graduation years	2009 (falling employment)	202 (79%)	53 (21%)	255 (22%)	3= 2009
		2008	218 (75%)	73 (25%)	291 (25%)	2= 2008
		2007	246 (80%)	63 (20%)	309 (25%)	1= 2007
		2006 (rising employment)	246 (75%)	83 (25%)	329 (28%)	0= 2006
Overall			912 (77%)	272 (23%)	1,184 (100%)	

One thousand and seventy five recent graduates had high socio-economic status, and 78% of them were employed compared to 71% of low socio-economic status. The

students' degree of social connection was modeled using another proxy, the parents' hometown, which was described as either local (within the metropolitan area of the university) or not local. Local was presumed to correlate with a high degree of social connections. Eight hundred ten recent graduates had a high degree of social connections and 80% of them were employed compared to three hundred seventy four recent graduates who were not local, of which 71% were employed.

4.9. Collinearity Testing

The collinearity testing included the linear combination test, bivariate test, the tolerance test, the variation inflation factor test, and condition number test. Each independent variable was carefully chosen to avoid a linear combination between any two of them. The bivariate correlation test was used to look for high correlations between pairs of variables. Results demonstrated no perfect correlation (correlation >90%). The correlation between graduates' SAT and QPA was 39% correlation, the same as the correlation between QPA and excellent student performance as an intern.

To test whether these levels of correlation could produce some collinearity problems in the logistic model, the tolerance (T) test, variation inflation factor (VIF) test, and condition number (CN) test were executed. A value of $T<0.1$, a value of $VIF>10$, and a value of $CN>15$ mean that there is a collinearity problem. The collinearity test showed that all values of T were >0.5 and VIF were <2, meeting the rules of thumb for T and VIF. In order to meet the rule of thumb of $CN<15$, the continuous variables were centered at zero. This gave a CN that was equal to 3.3, which is less than 15, avoiding any collinearity problems among the variables in the model.

4.10. Logistic Model Of Recent Graduate Employment

The binary dependent variable of employment:

$$y = Employment = \begin{cases} 0\ if\ the\ recent\ graduate\ was\ unemployed \\ 1\ if\ the\ recent\ graduate\ was\ employed \end{cases}$$

It is assumed that employment is a probabilistic process [36]. A binary outcome model gives the Probability of Employment (PE) for recent graduates within four months after graduation [90]; consequently, the analysis was done using a logistic model.

$$PE(Employment = 1 \mid independent\ variables\ )$$

$$= \frac{\exp\ (indepedent\ variables)}{1 + \exp\ (independent\ variables)} \qquad [1]$$

In terms of the latent dependent variables (y^*), equation 2 shows the general logistic regression model for the Probability of Employment for this study.

$$\boldsymbol{Employment}^* =$$

$$\beta_0 + \beta_1 * Gender + \beta_2 * Age + \beta_3 * SES + \beta_4 * SC + \beta_5 * SAT$$

$$+\beta_6 * QPA + \beta_7 * Major + \beta_8 * SPI + \beta_9 * NCI + \beta_{10} * Earliness \qquad [2]$$

$$+\beta_{11} * GY\ + \beta_{12} * interactions\ between\ variables$$

Table 4.3 shows the additive models (models 1 and 2) and the interactive models (3

and 4) for the study. Each previous model is nested in the new model. Model 1 had at least one independent variable for each component of Employability. The best additive model was Model 2. When QPA was added to the model, the LR test was not significant (LR=1.07, df=1, p = 0.302) and the AIC increased, so QPA was not included because it did not improve the model. Only two interactions were significant. Model 3 incorporated the interaction between major and students' performance as an intern, and Model 4 included the interaction between graduation years and the earliness of student's internship experience. Model 4 was the best interactive model because the LR test was significant (LR=9.92, df=3, p = 0.019), the AIC decreased (from 1260 to 1248), and the goodness of fit test was significant (p =0.350). Since interactions improved the model, average marginal effects (AME) at the means were needed to take into account both the main factors and the interaction factors on the Probability of Employment within four months following graduation.

A potential problem is that the residual variation could differ within the group [86]. If the homoscedasticity assumption does not hold, then the parameters are biased and the standard errors are invalid. As a result the inferences would be wrong [86-90]. Williams cited Hoetker, who had shown that " . . . in the presence of even fairly small differences in residual variation, naïve comparisons of coefficients can indicate differences where none exist, hide differences that do exist, and even show differences in the opposite direction of what actually exists" [88] Thus, we tested each independent variable using two Stata commands: *oglm* for *logit* [89] and *hetprob* for *probit*. Fortunately, the Model 4 did not exhibit any residual variation associated with an independent variable. QPA was tested for unobserved or neglected heteroscedasticity, as an omitted variable [86, 88-92],

both *oglm* for *logit* and *hetprob* for *probit* showed no significant heteroscedasticity in the residuals.

4.11. Results

As reported in Table 4.3, the factor in Model 4 with the greatest positive influence on the Probability of Employment (Odds Ratio 2.3) was receiving an internship performance rating of *excellent,* compared to students whose performance was rated s*atisfactory or poor* ($p < 0.01$).

The Probability of Employment is 2.1 times higher for recent graduates of engineering and technology majors than for recent graduates of business majors ($p < 0.05$). For students with a *good* internship performance, the odds ratio for employment was 1.6 higher than for students with *satisfactory or poor* performance ($p < 0.05$). But the potential influence on the Probability of Employment of *good and excellent* internship performance was diminished by the significant interaction with majors of engineering and technology by a factor of 0.24 for *good* performance as an intern ($p < 0.01$) and 0.35 for *excellent* performance as an intern ($p < 0.05$). The last column of Table 4.3 shows the Average Marginal Effects at the Means of the main variables in Model 4.

Table 4.3. Additive and interactive models for the Probability of Employment for recent graduates

Com-ponent	**Skill assessed by the firm Firm intern evaluation**	**Model 1 Additive**			**Model 2 Additive**			**Model 3 Interactive**			**Model 4 Interactive**			**Average Marginal Effects at Means**		
		OR		z-statistic	**OR**		z-statistic	**OR**		z-statistic	**OR**		z-statistic	**dy/dx**		z-statistic
Personal Circumstances	High Socioeconomic Status	1.29		1.10	1.28		1.04	1.34		1.24	1.37		1.33	0.06		1.26
	High Social Connections	1.63	**	3.21	1.61	**	3.10	1.57	**	2.92	1.55	**	2.83	0.08	*	2.74
External	External conditions 2007	1.35		1.53	1.38	+	1.64	1.37	+	1.61	1.36		1.56	0.05		1.56

Condition	External conditions 2008	0.97		-0.15	1.09		0.43	1.07		0.30	1.07		0.33	0.01		0.32
	External conditions 2009	1.26		1.14	1.54	+	1.86	1.56	*	1.89	1.78	*	2.35	0.08	*	2.23
Individual Factors	Male	1.36	+	1.86	1.40	*	2.08	1.41	*	2.12	1.41	*	2.12	0.06	*	2.18
	Age at graduation	0.92		-1.26	0.96		-0.60	0.97		-0.49	0.98		-0.33	0.01		-0.33
	SAT (admission score)	1.31	***	3.64	1.26	**	3.07	1.24	**	2.89	1.24	**	2.83	0.04	***	2.86
	Architecture and Design	1.45	*	2.12	1.32		1.36	1.47		1.28	1.45		1.23	0.05		1.49
	Engineering and Technology	0.85		-0.89	0.84		-0.90	2.07	+	1.83	2.13	*	1.89	-0.02		-0.42
	Good perform as an intern				1.13		0.67	1.58	*	1.93	1.57	*	1.89	0.01		0.34
	Excellent perform as an intern				1.84		3.19	2.19	**	3.04	2.25	**	3.14	0.10	***	3.14
	Three internships				0.87		-0.71	0.88		-0.62	0.85		-0.80	-0.03		-0.80
	Earliness of internship experience				0.96		-0.58	0.94		-0.73	1.02		0.11	0.00		-0.31
Interaction effects	Architecture and Design ***x*** Good perform as an intern							0.71		-0.84	0.75		0.69			
	Architecture and Design ***x*** Excellent perform as an intern							1.05		0.10	1.08		0.17			
	Engineering and Technology ***x*** Good perform as an intern							0.25	**	-2.86	0.24	**	-2.86			
	Engineering and Technology ***x*** Excellent perform as an intern							0.36	*	-2.10	0.35	*	-2.15			
	External conditions 2007 ***x*** Earliness										1.06		0.28			
	External conditions 2008 ***x*** Earliness										1.13		0.56			
	External conditions 2008 ***x*** Earliness										0.63	*	-2.24			
	Constant	0.40		1.52	1.19		0.61	0.98		-0.06	0.97		-0.09			
	Hosmer and Lemeshow Test (p)	0.871			0.210			0.982			0.348					
	Likelihood Ratio Test (p)	0.005			0.014			0.049			0.019					
	Parameters	10			14			18			21					
	Akaike Information Criterion	1260			1255			1253			1248					

+ p < 0.1, * p < 0.05, ** p < 0.01, *** p < 0.001

Age is centered at zero

SAT is standardized and centered at zero

Earliness is standardized and centered at zero

The innate intellectual ability as represented by SAT score was significant ($p < 0.01$). For one standard deviation change (std. dev.=117 points) in the score centered at zero (SAT of a graduate minus the mean of sample), the odds ratio for the Probability of Employment was expected to change by a factor of 1.2. In regard to personal circumstances, the Probability of Employment was 1.6 times higher for students who had a high degree of social connections (SC) and socio-economic status (SES) than students who had low degree of Social Connections ($p < 0.01$). We found that social

connectedness but not higher socioeconomic status, as measured by the type of high school attended, increased employment within 4 months of graduation.

One unexpected finding was that the Probability of Employment within four months following graduation increased in graduation years with falling job opportunities. As mentioned in Table 4.2, 2006 was the year with highest new job opportunities (> 38, 500 individuals were hired in a new position), followed next by 2007 (> 22,100 individuals were hired in a new position), and then 2008 (> 6,400 job positions were lost) and 2009 (> 23,000 employees lost their jobs), (Mexican Institute for Social Security, Sept 30th, 2011). Graduation year 2009 was particularly significant with odds of employment of 1.8 times higher than graduation year 2006 ($p < 0.05$).

The last column of Table 4.3 shows the results of the Average Marginal Effects at the Means. For individual factors, students with an *excellent* performance as an intern, the influence on the Probability of Employment was about 10 percent higher than for students whose performance was rated *satisfactory or poor* ($P < 0.001$); and for a standard deviation change in the SAT score centered at zero, the Probability of Employment increased by 4 percent ($p < 0.001$). Males had a 6 percent higher Probability of Employment than females ($p < 0.05$). In regards to personal circumstances, for recent graduates having a high degree of social connections, the Probability of Employment was found to be 8 percent higher than for those having low degree of social connections ($p < 0.05$). Finally, for the external conditions, students who graduated in 2009 were 8 percent more likely be employed after four mounts than those who graduated in 2006. ($p < 0.05$).

4.12. Hypotheses Testing and Conclusions

The study had four hypotheses concerning the Probability of Employment for recent graduates. First hypothesis was that the Probability of Employment would be higher for a graduate who performed better as an intern than for one who did not. A Wald test showed significance in favor of Hypothesis 1 ($p = 0.006$). Better performance as an intern was shown to increase the Probability of Employment for recent graduates within four months after graduation. This was found to be true.

The second hypothesis held that a greater number of internships during college would increase the likelihood of employment of recent graduates. In this case the Wald test was not significant. ($p = 0.422$).

The third hypothesis was that students with a higher socio-economic status and more extensive social connections would have a higher Probability of Employment after graduation. A Wald test showed significance to hypothesis 3. ($p = 0.003$). This means that a higher degree of these personal circumstances working together increase the Probability of Employment for recent graduates. The third hypothesis was found to be true.

Fourth hypothesis, that changing external conditions, represented by the graduation year 2007, 2008 and 2009 tested simultaneously, influenced the Probability of Employment of the recent graduates was marginally significant ($p = 0.053$). This supports the fourth hypothesis that the graduation year influenced the Probability of Employment of the recent graduates.

The study also tested whether the impact of a student's high performance as an intern had the same impact as a high degree of social connections on the Probability of Employment. A Wald test showed no difference between the impacts of these two factors

on the Probability of Employment ($p = 0.231$). This test showed that a student who had a better performance as an intern but did not have extensive social connections (e.g. students who are not local) could have a similar Probability of Employment as a student with low performance scores as an intern but extensive social connections.

4.13. Discussion

The study demonstrated that contextual factors are affecting Employability. It could be said that each recent graduate faced a different Employability situation based on the different individual factors and personal circumstances with which they faced labor market conditions following graduation. The study demonstrated that Employability is not an absolute attribute of a recent graduate; rather, it is a combination of individual, personal circumstances, and external factors.

The significant individual factors that had a positive effect on the Probability of Employment were *excellent* and *good* internship performance (consistent with Hypothesis 1), having engineering and technology majors, high admission scores, and being male. Social connections were significant, as an element of personal circumstances, and had a positive effect on the Probability of Employment, but socio-economic status *per se* was not significant. It is likely that the choice of high school type as a proxy for socioeconomic status was ill advised, as students from low-income homes can receive scholarships to attend private high schools. Unfortunately, privacy considerations prevented us from using a better indicator, when both of them were tested simultaneously; the two elements of personal circumstances were significant (consistent with Hypothesis 3).

Only the graduation year 2009 had a significant positive effect on the Probability of Employment within four months after graduation; but when all the graduation years were tested simultaneously they were significant determinants of the Probability of Employment (consistent with Hypothesis 4).

The significant variables of individual factors, personal circumstances, and the external conditions affirm the dynamic concept of employability stated by Hillage and Pollard [77], the adaptive and interactive nature of employability identified by Gazier [34, 76], and probabilistic process of employability articulated by Yorke [36].

The statistically insignificant and negative effect of the number of internship experiences (three internships vs. two) on the Probability of Employment challenged Hypothesis 2. There are at least two possible reasons for this result: the stock of human capital theory [93] and reservation wage and job matching. Each single component of a curricular model is intended to increase human capital by enable a graduate to participate in the labor market. Dustman and Meghir state, "… wages are match-specific [...] workers move jobs as a result of identifying a better match" [94] Thus, it is possible that graduates with more completed internships (human capital accumulation) could be looking for better opportunities. Alternatively, according to Van Ophem, Hartog and Berkhout, "the optimal strategy of an individual [i.e., a recent graduate] is to accept a job offer only if it exceeds the reservation wage" [95]. One of the benefits of the internships is giving recent graduates an understanding of the wage structure and the labor market, enabling them to make better decisions about job opportunities. At the time of the survey 17% of the respondents had one job offer and 44% of them had three or more job offerings.

In regards to public or private policy, the study showed that receiving *good and excellent* internship performance grades increases the Probability of Employment compared to *satisfactory* or *poor* internship performance within four months after graduation. The mandatory internship benefitted the recent graduates enhancing their Employability only when their internship performance was ranked highly. More than three internships had a negative effect on the Probability of Employment within four months after graduation compared with two internships. The earliness of internship experience did not have a significant effect on the Probability of Employment within four months after graduation. These two variables were not statistically significant. More data are needed to define the optimal number of internships and the best time to start the internship experience.

4.14. Limitations

The limitations of this study are related to the measurement of some of independent variables. For socioeconomic-status, the best measure would have been parents' annual income, but this information was not available. In addition, some of the participants in this study may have had a scholarship to a private high school, making this variable noisy. Finally, using parents' hometown to assess the family social connections presumes that an alumnus has better networking options for employment if his/her parents live in the same city as the university. However, the study did not account for the fact that non-local students could also create their own network rather than depend solely, or in part, on their parents' connections or that they could be employed elsewhere.

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Chapter 5

5. Conclusion, Policy Recommendations, Limitations and Future Research

5.1. Conclusions

Internships help students develop or consolidate skills for the workplace by giving them opportunities to nurture relevant skills, to be more innovative professionals and to develop their Employability. In this sense, the most original contributions of this thesis are the following findings:

A. From the internship outcomes model, the analysis identified the importance of the following:

1) **Understand needs of internal and external clients:** better understanding needs of clients, with the biggest effect and the strongest significance among 21st Century Skill Categories, increased the effect on the three internship outcomes: task performance, learning new knowledge, and overall performance.
2) **Self-update:** the proactivity in her/his professional self-update, had the biggest effect and was found to be a highly significant intrapersonal skill, contributing to enhance learning new knowledge and overall performance.
3) **Problem-solving process:** the whole set of cognitive skills tested, a kind of general process to solve problems, enhanced task performance.
4) **Collaboration:** better work with members of other areas, as the only tested interpersonal skill with highly significant effect, also increased the effect of task performance and overall performance.

5) **Period to execute an internship:** Summer was identified as recommended period to execute an internship, as the strongest significant control variable, associated with improved learning new knowledge compared with spring and fall.

This thesis confirmed the theoretical notion stated by Goleman [54], Whetten & Cameron [55], and the Committee on the Assessment of 21st Century Skills of the NRC [18], that cognitive skills are necessary but not sufficient for success in executing complex professional tasks. Interpersonal and intrapersonal skills are needed as well.

B. From the individuals' innovation model, the analysis identified the importance of the following:

1) **Innovation skills:** Better Discovering and Developing skills had good significance and Deploying had moderately significance. All of these had a positive effect on the Individuals' Innovation Capability.
2) **Self-development:** self-update had good significance and positive effect on increasing the Individuals' Innovation Capability.

Thus, the study partially confirmed the four D's of the 4D innovation model. Only Discovering and Developing were found highly significant, Deploying was found marginally significant, and the skill of Defining was not statistically significant in predicting Individuals' Innovation Capability.

C. From the Employability model, the analysis tested the importance of the following:

1) **Performance as an intern:** excellent student performance as an intern enhanced by 10% the Probability of Employment of recent Mexican college graduates, compared

with satisfactory performance.

2) **External conditions of the labor market:** Surprisingly, I found statistically significant that in years with falling job opportunities, the Probability of Employment within four months following graduation increased by 8% for recent Mexican college graduates compared with years with increasing job opportunities.
3) **Number of internships**: More than three internships had a negative effect on the Probability of Employment within four months after graduation compared with two internships, but this effect was not statistically significant.
4) **Earliness of internship experience:** The earliness of internship experience, measured in months from the first day as an intern to graduation day, did not have a significant effect on the Probability of Employment within four months after graduation.

I found that contextual factors such as the current labor market affect Employability, as much as or more than the individual's attributes or personal circumstances. This reflects the dynamism of employability as stated by Hillage and Pollard, the adaptive and interactive dimension identified by Gazier, and probabilistic process of employability articulated by Yorke. The study demonstrated that employability is not an absolute attribute of a recent graduate; rather, it is a combination of individual attributes, personal circumstances, and external factors.

The statistically significant individual factors that had a positive effect on the Probability of Employment were excellent and good internship evaluations, being a recent graduate in engineering and technology majors, having a high admission score, and being male. Social connections were significant, as an element of personal

circumstances, and had a positive effect on the Probability of Employment, but socio-economic status per se was not significant. Yet, when both of them were tested simultaneously, the two elements of personal circumstances were statistically significant.

5.2. Policy Recommendations

The Mexican Constitution and the related laws require a Social Service activity for all Mexican college students in order to obtain a higher education degree [36, 37]. The Social Service is implemented under two approaches: (a) socially-oriented experience, and (b) professionally-oriented experience – the internship. Each higher education institution is responsible for its inclusion of the curricular program, but the vast majority of Mexican universities allow the internship option. An internship program is permitted for a regular student who meets some academic requirements, and the Mexican Law of Professions requires an internship tutor to advise, support and assess interns. My work was undertaken to improve educational outcomes, produce a well-trained workforce, and meet employer needs, and to allow us to answer questions such as, is this policy helping the students to find jobs and/or they are improving their innovative characteristics? Is it implemented efficiently for the Higher Education Institutions? Is it well supported and advisable for firms? Might the Mexican government design a specific public policy for each of the Social Services approaches?

The Mexican government should require the higher education institutions to assess the effect of the Social Service approaches (socially, professionally) that are currently implemented in order to evaluate its intended purpose. According to my findings I recommend that the number of internship should be regulated up to two internships in

order to foster the Probability of Employment. Additionally, the government should regulate the number of courses students take in a regular semester (spring or fall) or allow full time internship (similar to UK Apprenticeships or the CO-OP program) because I found that performing an internship during the regular fall and spring academic semesters had a negative effect on learning, overall performance as an intern, and the innovation capability compared to internships completed in the summer.

Higher Education Institutions should design the internship experience in order to improve the students' internship performance, paying attention to the skills associated with the 21st Century Skills Categories: cognitive (problem-solving process), intrapersonal (self-update) and interpersonal (collaboration). Firms and universities (as particular policy according with the Mexican Social Service, the Law of Professions) might consider scheduling the most complex and interesting internships in summer. It could help the small business enterprises, which are more than the 98% of the Mexican companies, to innovate their product, service, production process technology, new form of commercial business, new market or source of supply, etc.

Universities should develop pedagogical and instructional methods and/or educational standards for teaching and/or training individuals in the following skills to enhance complex professional tasks and Individuals' Innovation Capability:

a. Self-development -proactivity for professional self-update
b. Defining -understanding internal and external clients
c. Planning -prioritizing and scheduling internship activities
d. Discovering -relevant information to solve a problem or a opportunity innovation,

e. Developing -practical ability to apply his/her technical knowledge in a solution,
f. Deploying -good engineering judgment to implement the best solution
g. Written communication -writing reports to share information, oral communication
h. Expressing ideas clearly and confidently
i. Adaptability -working in ambiguous situations
j. Collaboration -work with other members of the firm to get a result.

In the Mexican context, these educational standards can support the National Register of Competency Standards foster Employability and Individuals' Innovation Capabilities (workers, students and employers).

A consideration to take into account concerning these recommendations in Mexican educational public policies is that the State universities are autonomous, they do not respond to federal or state policies or the national secretary of education. In private universities, it is easier to implement an educational public policy because they are highly regulated by the government. This could have specific implications for internship standards, profiles of the academic and industrial tutors, and the accountability for skills assessment, student, internship-project, university, and firm information.

5.3. Limitations

For the internship outcomes and individuals' innovation studies, one interpretation of those findings with significance above the accepted level is that, while the identified skills are indeed important, the variations among interns meant that not all innovation skills were relevant to the innovation capacity of all interns. Considering this variability, a larger sample size would help clarify the statistical significance of the models

Mexican laws of access to public information and private data protection protect some student data, for example, information about their parents' assets and other personal information. This led to some challenges in the internship and employability study. For instance, the best measure of socioeconomic-status would have been parents' annual income, but this information was not available. Instead I had to use whether or not the students had attended a private high school. Since some of the students may have had a scholarship to a private high school, this variable was noisy. I used parents' hometown to assess the family social connections, assuming that an alumnus has better networking options for employment if his/her parents live in the same city as the university.

5.4. Future Research

This thesis has analyzed the effect of college internships on the Mexican workforce based on significant datasets from both a university and a major employer, over a number of years, using state of the art methodology, to address multiple important research questions. For such a significant topic, however, there are opportunities to build on the insights from this work, and to apply additional methodological approaches. The following sections address these opportunities.

5.4.1. Qualitative analysis

Qualitative analyses could be executed in order to enrich or complement the analyses reported here [96]. I could apply the interview or focus group method in order to get information from tutors, academic directors, professors, students and interns. The themes that I would explore are directly associated with the unexpected results. Qualitative analysis could help me to understand deeply, in the Mexican internship

context, the unexpected effects of the following variables: the 2009 external economic condition on the Probability of Employment, interns' skill seeking feedback on their main task performance, and interns' skill at "defining" and fall and spring as academic periods when internships were executed on Individuals' Innovation Capability.

For related studies in others countries, such as U.S.A., qualitative analysis would be the first step towards understanding differences and similarities about education, policies, and students.

5.4.2. Cross Validation Analysis

A cross validation analysis could be executed to "tune parameters" of each of the models to check replicability. The processes to execute the *k-fold cross validation* [97]:

1. Re-run the regression analysis saving the fitted values.
2. Calculate the area under the Receiver Operating Characteristic (ROC) curve using the predicted values
3. Break randomly the database into *k* mutually exclusive samples of equal size of interns.
4. Refit the model *k* times and get the estimated parameters using the remaining interns, each of *k-folds* should be set-aside in turn.
5. Using the parameter estimates from each *k* regressions, the statistics necessary to calculate the predicted error are estimated for the corresponding set-aside interns.
6. Predicted values should be calculated using the statistics from all k samples.
7. The procedure should be repeated *h* times, using a new sample of the database each

time, and then the *h* summary of predicted values should be averaged. Reasonable values for *k* and *h* are *k* = 5 to 10 and *h* = 10 to 20.

8. The cross-validated area under the ROC curve should be calculated using the averaged predicted values.
9. Compare the areas under the ROC curve form step 2 (optimistic estimate) and step 8 (cross-validated estimate).
10. Make conclusions.

5.4.3. Instrumental Variables Analysis

When a regression model has an endogenous variable, the estimated parameters are inconsistent. A variable is endogenous when their values are determined within the model, it has internal cause or origin, in other words, it is a variable jointly determined with the dependent variable and it is correlated with the error term. Endogeneity generally appears in one of the three ways: omitted variables, measurement error and simultaneity [91, 92]. Because of conceptual similarities between variables, I suspect potential endogeneity between the following variables: learning new knowledge and task execution, task performance and overall performance, and learning and Individuals' Innovation Capability.

Instrumental variables (IV), called instruments (*z*), are the most common way to address the endogeneity problem. The biggest challenge in an IV analysis is finding a valid instrument (*Z*) that is correlated with independent variables (*X*) but not with dependent variables (*Y)*. Some researchers suggest that one could use variables in another equation, look for exogenous variation (*Z*) that is "as if" randomly assigned (It does not

directly affect *y*, but affects *x*). Qualitative analysis could help to find a valid IV is based on deep substantive knowledge of the processes shaping *x* and *y*.

The instrumental variables estimator provides a way to obtain consistent parameter estimates. This method, widely used in econometrics and rarely used in other fields, is conceptually difficult and easily mistreated [91]. Call y_1 the dependent variable of the structural model:

$$Y_i = \beta_0 + \beta_1 X1_i + W_i\beta_2 + u_i \quad [5.1]$$

Where $X1_i$ = endogenous regressors and W_i = exogenous regressors. IV procedure has two stages. According with the Wooldridge's procedure and assuming that Z_i is a valid instrumental variable; the key idea is that the first stage isolates part of the variation in X_{1i} that is uncorrelated with u_i [91].

1. Obtain the fitted values $\widehat{X1}_\iota$ from the regression:

$X1_i$ on Z_i and W_i; → $X1_i = \pi_0 + \pi_1 Z_i + W_i\pi_2 + v_i$ [5.2]

Equation 5.2 is called the first-stage regression or reduced form equation.

2. Run the OLS regression:

Y_i on $\widehat{X1}$ and W_i; → $Y_i = \beta_0 + \beta_1 \widehat{X1}_\iota + W_i\beta_2 + u_i$ [5.3]

Equation 5.3 is called the second-stage regression, and it produces consistent estimates $\widehat{\beta_J}$ because of $\widehat{X1}_\iota$ is uncorrelated with u_i. The resulting estimator is called the $\widehat{\beta_1}$ two stages least squared estimator (2sls estimator).

A valid instrumental variable must meet two conditions:

1. **Relevance condition:** *corr* $(Z_i, X_i) \neq 0$ this can be tested directly. At least one IV

must enter in the first-stage regression. Generalizing the IV procedure, instruments are said to be weak if all the $\pi_1, \pi_2, \ldots \pi_m$ are either zero or nearly zero. Totally irrelevant instruments occur if all the coefficients on $Z_1, Z_2 \ldots Z_m$ are zero.

2. **Exogeneity conditions:** *corr (Z_i, u_i) = 0* this cannot be tested directly. All the instruments must be uncorrelated with the error term u_i. The 2sls estimator is inconsistent if the instruments are correlated with the error term, the first-stage regression does not successfully isolate a component of X_i that is uncorrelated with the error term, so $X1_i$ is correlated with u_i.

Stata® has different commands to apply IV method for cross sectional data according with the type of the dependent variable: linear regression (*ivregress*, *ivreg2*), probit regression (*ivprobit*), and Tobit regression (*ivtobit*). None of them work the second stage with ordinal variables. Using predicted values in a nonlinear second-stage regression does not result in a consistent estimator. Using the Stata command called *ivreg2*, one can execute the following procedure in order to address the potential endogenous regressors [98]:

1. **Heteroskedasticity***:* It is important to know if the endogenous model has heteroskedastic residuals. The Pagan-Hall test has the null hypothesis where the residuals are homoskedastic. After running the ivreg2 command, the post estimation command called ivhettes test this null hypothesis.
2. **Endogenous regressors:** The Durbin-Wu-Hausman test has the null hypothesis that the specified endogenous variables can actually be treated as exogenous. At the end of the second-stage regression, the result is reported.
3. **Identification and the rank condition:** The order condition for identification implies that instruments (Z) should have at least the same number of endogenous regressors (W). The canonical correlation of the all-endogenous regressors must be significantly

different from zero. If one or more of the canonical correlations is zero, the model is underidentified or unidentified. The Anderson canonical correlation test has the null hypothesis that the smallest canonical correlation is zero. When the model has heteroskedastic disturbance, Kleibergen-Paap have developed the *rk- statistic* to deal with robust statistics.

When using more instruments than endogenous regressors, the test for overidentification is needed. The Sargan test has the null hypothesis that overidentifying restrictions are valid or the equation is not exactly identified. When the model has heteroskedastic disturbance, the Hansen's test use the *J-statistic*. The null hypothesis is that the instruments set is appropriate.

4. **Underidentification and instrument redundancy**: The Cragg–Donald's statistic and the Anderson's canonical correlations test are the ways to test for underidentification. It is recommended to drop redundant instruments. Test a set of instruments for redundancy; the Breusch test is used with the null hypothesis that the specified instruments are redundant.
5. **Weak identification:** To identify a weak instrument, the Cragg–Donald *F-statistic*, requires an assumption of independent and identically distributed (*i.i.d.)* errors. The null hypothesis is that the equation is weakly identified. If the *F-statistic* is less that 10 then the equation is weakly identified. When the model has heteroskedastic disturbance, Kleibergen-Paap *rk*-statistic should be used.
6. **Inference robust to weak identification:** Anderson and Rubin's test where the null hypothesis tested is that the coefficients of the endogenous regressors in the structural equation are jointly equal to zero. The *Anderson–Rubin statistic* is robust to the

presence of weak instruments.

In sum, if the instrumental variable or a set of them is relevant and exogenous, we can use it in order to address the identified potential endogeneity. If not we should continue to search for one that meet all of the tests described above.

I tried to identify a relevant and exogenous instrument for learning new knowledge using the following variables as external motivation to improve interns' learning new knowledge: Foreign Direct Investment (FDI) at level of the state, industrial sector (manufacture) and sub-sector (metal), the numbers of college graduates for type of university in the state, Gross Domestic Product (GDP) of the state. Most of the variables were collected for year, six months, and each month. The number of graduates for type of university and the GDP did not work as a valid instrument. The FDI at level of the state works as a valid instrument when it was related with the academic period. The FDI of the state from January to May was associated with spring, June and July with summer, and from August to December with fall.

Table 5.1 shows the result of the procedure, explained above, to test FDI at state level as instrument (*Z*), as a valid instrument, for the learning new knowledge as an endogenous regressor (*W*). The equation 5.4 is called structural equation:

$$\boldsymbol{Task\ performance}_i =$$

$$\beta_o + \beta_1 Cognitive\ Skills_{ij,1} + \beta_2 Intrapersonal\ Skills_{im,2} +$$

$$\beta_3 Interpersonal\ Skills_{in,3} + \beta_4 Control\ Variables_{ip,4} +$$

$$Learning\ new\ knowledge_i \beta_4 + u_i \qquad [5.4]$$

Table 5.1 Testing for valid instrument

Step	Test and null hypothesis	Results
1. Heteroskedasticity	*Pagan-Hall's test* Ho: Residuals are homoscedastic	*p-value* = 0.649, Residuals are homoscedastic
2. Endogenous regressors	*Durbin-Wu-Hausman's test* Ho: The specified endogenous variable can actually be treated as exogenous.	*p-value* = 0.046, learning new knowledge can be treated as endogenous
3. Identification and the rank condition	Order condition *The Anderson canonical correlation test* Ho: The smallest canonical correlation is zero. *The Sargan test* Ho: Overidentifying restrictions are valid or the equation is not exactly identified.	One endogenous regressor and one instrument. *The Anderson canonical correlation test* *p-value* = 0.000, FDI at state level is identified as an instrument. *The Sargan test* *p-value* = 0.000, FDI at state level is exactly identified.
4. Underidentification and instrument redundancy	Does not apply	Does not apply
5. Weak identification	*Cragg–Donald's F-statistic* Ho: the equation is weakly identified	*F= 28.48,* FDI at state level shows a strong relevance as an instrument
6. Inference robust to weak identification	*Anderson and Rubin's test* Ho: coefficients of the endogenous regressors in the structural equation are jointly equal to zero.	*A-R Wald test, p-value=0.567* *A-R Wald test, p-value=0.554* *Stock-Wright, p-value=0.554* The Anderson–Rubin Wald test and Stock–Wright LM test readily accept their null hypothesis and indicate that the endogenous regressors are NO relevant.

In sum, The FDI at state level is a relevant and exogenous, valid instrument for learning new knowledge; we can use it order to address the identified potential endogeneity with task main performance. The first-stage regression is shown in equation 5.5 and the second-stage equation is in equation 5.6.

1. First-stage:

$$\boldsymbol{Learning\ new\ knowledge}_i =$$

$$\beta_o + \beta_1 Cognitive\ Skills_{ij,1} + \beta_2 Intrapersonal\ Skills_{im,2} +$$

$$\beta_3 Interpersonal\ Skills_{in,3} + \beta_4 Control\ Variables_{ip,4} +$$

$$FDI\ at\ state\ level_i \beta_4 + v_i \qquad [5.5]$$

Obtain the fitted values $\widehat{X_J}$= cognitive, intrapersonal, interpersonal skills.

2- Second-stage

$$\boldsymbol{Task\ performance}_i =$$

$$\beta_o + \beta_1 \widehat{Cognitive\ Skills}_{ij,1} + \beta_2 \widehat{Intrapersonal\ Skills}_{im,2} +$$

$$\beta_3 \widehat{Interpersonal\ Skills}_{in,3} + \beta_4 \widehat{Control\ Variables}_{ip,4} +$$

$$FDI\ at\ state\ level_i \beta_4 + u_i \qquad [5.6]$$

Table 5.2 shows the coefficients of the best linear model for main tasks performance (see Table 2.7) compared with the instrumental variable analysis.

After apply FDI at state level, the model shows very similar coefficients in magnitude and signs, the significance level of the variables improved. The R-squared was similar and the AIC decreased in 33 points. Now the coefficients are valid, exogenous and consistent.

Table 5.2 Linear models for main tasks performance compared with the instrumental variable analysis

Components	Skill assessed by the firm Firm intern evaluation	Endogenous linear Model			Instrumental Variable		
		ß		p	ß		p
Cognitive Skills	Understands needs of internal and external clients	0.19	***	0.000	0.20	***	0.000

	Planning and scheduling internship activities	0.09	**	0.002	0.10	**	0.001
	Proactivity to locate contacts who have relevant info.	-0.07	*	0.020	-0.08	*	0.017
	Practical ability to apply his/her technical competencies	0.08	*	0.031	0.08	*	0.025
	Good judgment to implement his/her ideas	0.07	*	0.048	0.08	*	0.040
	Writing reports to share information	0.12	**	0.001	0.12	***	0.000
Intra-personal Skills	Proactivity in his/her professional self-update	0.04		0.242	0.05		0.193
	Seeks for feedback	-0.06	+	0.054	-0.06	*	0.044
	Tolerates frustration due to difficulties and failures	0.06		0.104	0.06	+	0.088
	Works in ambiguous situations	0.09	**	0.009	0.09	**	0.008
	Recognizing and appraising contributions from others	0.04		0.296	0.04		0.308
Inter-personal Skills	Expresses his/her ideas clearly and with confidence	0.05		0.178	0.04		0.213
	Utilizes various ways to build a network	0.06		0.102	0.06	+	0.092
	Works with members of other areas	0.08	*	0.021	0.08	*	0.020
	Ability to coordinate tasks in a group	0.03		0.453	0.02		0.497
Control Variables	Female *(Baseline=male)*	0.02		0.617	0.02		0.533
	Fall	0.02		0.743	-0.01		0.850
	Spring	0.01		0.890	-0.04		0.654
	Chemical *(Baseline=industrial)*	0.09		0.145	0.09		0.151
	Materials and Mechanical	0.03		0.510	0.04		0.449
	Business	0.09		0.222	0.10		0.193
	Electronics	-0.07		0.227	-0.07		0.197
	Others	0.17		0.102	0.16		0.124
	Public Tech Institutions *(Baseline=Private Tech Institution)*	0.22	*	0.012	0.22	**	0.011
	Public Universities	0.11	*	0.026	0.11	*	0.022
	Private Universities	0.05		0.299	0.05		0.262
	Engineering and Technology *(Baseline=Human Resources)*	0.09		0.123	0.09		0.101
	Management and Finance	0.02		0.818	0.02		0.853
	Operations	0.11	*	0.023	0.11	*	0.019
Instrument (*Z*)	FDI at state level				-0.05		0.567
	Constant	0.41	***	0.000	0.44	***	0.001
	R-squared	0.72			0.71		
	Parameters	29			30		
	Akaike Information Criterion	448			481		

+ $p < 0.1$, * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Overall performance and Individuals' Innovation Capability are ordinal variables (five-point Likert scale). Although Likert-type scales are theoretically ordinal variables, most researchers treat them as continuous variables. When an ordinal variable has 5 or more categories there is relatively little harm in treating it as a continuous variable [99, 100]. I would like to compare the result of ordered logistic regression, ordered probit regression and linear regression using the five-point Likert scale in order to compare magnitudes, signs and level of significance of each of the coefficient. If the performance

of the three models remains similar, I would like to know if one of the instrumental variables could be a relevant and exogenous instrument for overall performance and innovation capability.

In this sense, continuous variables are needed for overall performance as an intern and for Individuals' Innovation Capability in order to have consistent 2sls estimators. The questionnaires applied should be redesigned in order to get an assessment with continuous variables for most of the variables in the model.

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Appendix A: Firm Instrument to assess internship outcomes performance

Skill	Very Poor Performance	Poor Performance	Satisfactory Performance	Good Performance	Very Good Performance
Learning new knowledge (up to five)					
Main task execution (Up to three)					
Objective execution (Up to three)					
Innovates and contributes with original ideas					
1. Professional Expertise					
1.1. Possesses specific knowledge and skills of his/her profession					
1.2. Practical ability to apply his/her Professional Competences					
1.3. Good judgment to implement his/her ideas					
1.4. Utilizes various ways to network building					
1.5. Proactive in his/her professional self-update					
1.6. Shows maturity about his/her professional growth expectations					
2. Business management					
2.1. Connects project objectives with the company's objectives					
2.2. Aligns projects activities with sector targets					
2.3 Planning and scheduling his/her activities					
2.4. Establishes priorities and reports achieved results on time					
2.5. Recognizes mistakes and reacts with a continuously improving attitude					
2.6. Makes his/her job methodological achieving all quality standards					
3. Drive for results					
3.1. Responsible for his/her specific role					
3.2. Completes tasks and achieves the objectives					
3.3. Exceeds requirements and goes beyond					
3.4. Self-motivation without external stimuli					
3.5. Tolerates frustration due to difficulties and failures					
3.6. Works in ambiguous situations					
3.7. Intern maintains his/her effectiveness under pressure					
4. Client focus					
4.1 Understands needs of internal and external clients					
4.2. Considers the impact of his/her tasks on other projects					
5. Interpersonal skills: 5.1 Teamwork					
5.1.1. Achieves an appropriate link with his/her leader					
5.1.2. Integrates his/her work with his/her sector/department					
5.1.3. Works with members of other sectors					
5.1.4. Contributes to a good working environment					
5.1.5. Recognizes and appraises contributions from others					
5.1.6. Ability to work in multidisciplinary/multicultural teams					
5.1.7 Listens and understands ideas of speaker					
5. Interpersonal skills: 5.2. Communication					
5.2.1 Listens and understands ideas of speaker					
5.2.2. Seeks feedback					

5.2.3. Expresses his/her ideas clearly and with confidence					
5.2.4 Presents reports in a professional way					
5. Interpersonal skills: 5.3. Leadership					
5.3.1. Influences his/her group by persuasion and consensus					
5.3.2. Has ability to coordinate group tasks					
5.3.3 Achieves respect and authority					
6. Knowledge: 6.1 Searching information					
6.1.1. Finds relevant information for his/her project					
6.1.2. Proactive to locate contacts who have relevant information					
6. Knowledge: 6.2 Using and applying knowledge					
6.1.2. Takes advantage of the existing knowledge of the firm					
6.2.2. Avoids designing processes or tasks from scratch					
6. Knowledge: 6.3 Sharing knowledge					
6.3.1. Shows a positive attitude towards sharing knowledge					
6.3.2. Writes report for information sharing					
6. Knowledge: 6.4 Explicit knowledge					
6.4.1. Makes documents to share knowledge					
6.4.2. Develops industrial and administrative procedures for the tasks performed					
6.4.3. Inventories best practices for his/her project					
Overall performance					

Appendix B: AIC Formulas

Akaike Information Criterion is defined as

For *ologit, oprobit, logit*: AIC = −2 ln(L) + 2k [Annex 1]

where ln(L) is the maximized log-likelihood of the model and k is the number of parameters estimated. Some authors define the AIC as the expression above divided by the sample size.

For linear: AIC = n*ln(RSS/n) +2*(k+1) [Annex 2]

where RSS is Residual Sum Squared, n is the number of observations and k is the number of parameters estimated.

Example:

1. From Table 2.9: Model 4 has Log Likelihood = -164

AIC = -2(-164) + 2(31) = 390

Source: StataCorp. 2011. *Stata Statistical Software: Release 12*. College Station, TX: StataCorp LP.