LINKING ACADEMIC ENVIRONMENT TO BUSINESS COMMUNITY THROUGH INNOVATION NETWORKS: A STUDY ON ROMANIAN HIGHER EDUCATION CHALLENGES

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Abstract

The paper is addressing the complex challenges of academic environment in the framework of technological education. A "sine qua non" condition for creating an appropriate teaching environment that allows technical students to acquire useful business and managerial competencies is to deeply understand the business community needs. Thus, the authors have conducted a comparative study aimed to bridge the gap between the offer and the demand with respect to business and managerial competencies ensued by engineering education.

The methodological approach was twofold:

- A qualitative research on business and managerial competencies ensued by the programs of study within a public higher institution
- A quantitative research on assessing the managerial competencies required by the business community so that engineers should be prepared to add value to the companies.

Based on the research results, the authors share their views regarding how both academic environment and business community could take advantage of building innovation networks. This network aspect of the innovation processes fosters "cluster of innovation" and cooperation between teams of students, educators and entrepreneurs. In this way all parties involved will benefit from networking opportunities with respect to initiate collaborative projects and share information, knowledge, and experience.

Finally, the higher education institutions should be aware of the heterogeneity of the stakeholders' needs and expectations, and carefully create a continuous improvement culture within networks in order to constantly focus on meeting business community requirements in terms of managerial competencies. In this light, the authors have placed great emphasis on curriculum development that focuses on the challenges of engineers as future managers and entrepreneurs. The necessary improvements have been incorporated in the business education courses with the aim to keep engineering students abreast of the best management practices within the business community.

Key words: innovation, education, innovation networks, continuous improvement, curriculum development, managerial competencies

1. Introduction

Globalization, as the major business trend, has led to important changes in the European environment, creating both opportunities and challenges for global business. Within Europe, there have been made many efforts to encourage cooperation and partnership between different regional economies in many areas, such as technology, education, ITC, etc. Many of these initiatives were aimed to share economic development and mutual understanding of different cultures. In this context, it is worth to be pointed to the Bologna Process, launched in 1999 with the aim to encourage and enhance the exchanges of experiences in the areas of science, technology, and information communication technology in order to bridge the gap between different European countries. Thus, the importance of strategic and sustainable partnership at the national, regional, and local level for an enhanced regional sustainable development process is substantially increasing.

Last year Romania became a full European Union Member State and it has taken the appropriate steps towards complying with the principles of the Bologna Accord. Consequently, based on the recommendations articulated in the new education law, Romania has reorganized the entire education system to assure academic standards that improve the quality of European higher education. As a "new entry" country in European Union, Romania is facing with a very competitive educational environment at the national and the international level. In such an environment, the business and managerial approach at all levels is no longer a useful recommendation and it is rapidly becoming an important requirement of higher education systems.

Today, more and more employers are looking for graduates trained in business skills. This subject is of increasing interest especially for engineering students who are encountering a highly exposure to managerial responsibilities. As consequence, one of the key opportunities to create an innovative and entrepreneurial labor force is to accelerate the education processes through building effective networks.

2. Theoretical Framework

As mentioned above, for the economic and cultural development of Romanian business community, the role of management and business competences has an increasingly pervasive aspect of engineering education. In this regard, a "sine qua non" condition for developing an adequate technological education environment is to understand the competence concept, properly.

In the scientific literature, the term competency has paid attention to a lot of researchers and scholars. Some researchers, including Prahalad and Hamel (1990), have treated

competency as an entity of an organization. This approach explains why a certain leader is not necessarily competent in another organizational environment. In the same light, other distinguished specialists have introduced the core competency concept. Core competency is something that the organization owns, being in fact the cumulative competence of organization. Based on this idea, Bratton (1998) have pointed to the core competency as any knowledge, skill, trait, motive, attitude, or other personal characteristic essential to perform a job.

Another interesting attempt in this matter has treated competencies of employees, defining job competency as "an underlying characteristic of a person which results in effective and/or superior performance in a job" (Boyatzis, 1982). Within this model, the researcher highlights that the underlying characteristics could be a trait, skill, social role or a body of knowledge.

According to the literature, organizational and employees competences are tightly connected in the sense that personal core competences are said to be derived from the values and core competencies of the organization (Reagan, 1994). Moreover, organization that use core competency-based systems for their employees are often referred to as visionary or high-performance organizations (Collins & Porras, 1996).

Further developments in the field have viewed the competency as "an underlying characteristic of people that is causally related to criterion-referenced effective and/or superior performance in a job or situation" (Spencer & Spencer, 1993). The background idea emphasizes the underlying, unseen structures and processes inside a person that explains why each person′s behavior tends to be relatively similar across different situations, yet also different from another person′s behavior. In other word, the individual′s competency indicates the ways of thinking and behaving in different situations, being characterized by five elements such as motives, traits, self-concept, knowledge and skill necessary for successful job performance.

A deeper analysis provides a useful insight about the trait approach of competency. According to Hogan and Holland (2003), traits refer to occurring regularities or trend in a person′s behavior. Although traits can not be seen, they can be inferred from consistent patterns of behavior and reliably measured by personality inventories. As consequence, organizations use different kind of personality assessment instruments when using trait approach for increasing employees' awareness and competences.

Another valuable contribution to exploring the competency concept was brought by Quinn et al. (1996), who has defined competency as both the possession of knowledge and the behavioral capacity to act appropriately. They proposed an interesting concept, named

behavioral complexity, as the ability to act out a cognitively complex strategy by playing multiple roles in an integrated and complementary way. Thus, developing competencies has required mastering knowledge and having the opportunity to practice the skills. In this light, researchers also defined the skill concept as a hypothetical concept which explain why behavior is changed through experiences and learning and why some individuals are more effective than others (Singleton, 1983).

Concerning the managerial competencies, it is interesting to note that current literature addresses the managerial competencies and performance management. An interesting contribution to describing the relationship between the two concepts was brought by Pickett (1998) who has stated that "managerial competencies provide a sound basis for an effective performance management program; using information obtained during the review of competencies required by the job and those possessed by the person performing that job, an integrated process can be introduced linking competencies with the annual performance review program and the determination of objectives".

In the same light, the specialists viewed organizations that use performance management programs as high-performance organizations, because effective performance management will serve as a key lever of change that boosts individual and team accomplishment (Moravec, 1996).

Valuable researches in the field have distinguished six managerial competencies that appear to be critical to the success of managerial employees, such as leadership skills, customer focus, result oriented, problem solver, communication skills, and team worker (Abraham, Karns, Shaw & Mena, 2001). Consequently, the study emphasizes the value of identifying the managerial competencies critical for successful performance, but also insuring that those same competencies are incorporated in the performance appraisal process.

In the area of managerial competencies it is noteworthy two key aspects: *management knowledge* and *managerial behavior*. *Management knowledge* is only one element of competence and is related to knowing and understanding a wide range of management concepts. In today's context where technology, globalization, and frequent changes combined create a highly complex and challenging environment, the significance of management knowledge is substantially increasing. Thus, it has to integrate different perspectives and disciplines in a cohesive whole that enables individuals to accomplish managerial jobs, successfully.

As for *managerial behavior*, it can be observed and measured because is related to putting the knowledge into action. This is the most difficult aspect, because the competency is

manifested through concrete actions in the ability to act effectively in a certain situation. According to the scientific literature, there are a lot of variables affecting managerial behavior such as attitude, skills, and experience (Hughes, Ginnett & Curphy, 2006).

Finally, after a documented research in the scientific literature, the authors have focused on approaching managerial competence as an integrated result of two key factors: management knowledge and managerial behavior, which enable managerial employees to accomplish good performance in certain situations. As consequence, figure 1 presents the managerial competence approach used for our study.

Because of the competency is viewed as the ability to act and apply knowledge, the authors have considered employees′ attitudes and skills as a subset of managerial behavior concept. Even though attitude is an important element of competences including for example the motivation to use the skills, experience – the practice of skills - is also important. Many competencies, especially managerial ones, need a wide experience background before they really develop. Thus, managerial competence is the output of the learning process, being something that people (e.g. engineering students) can train and develop through education processes.
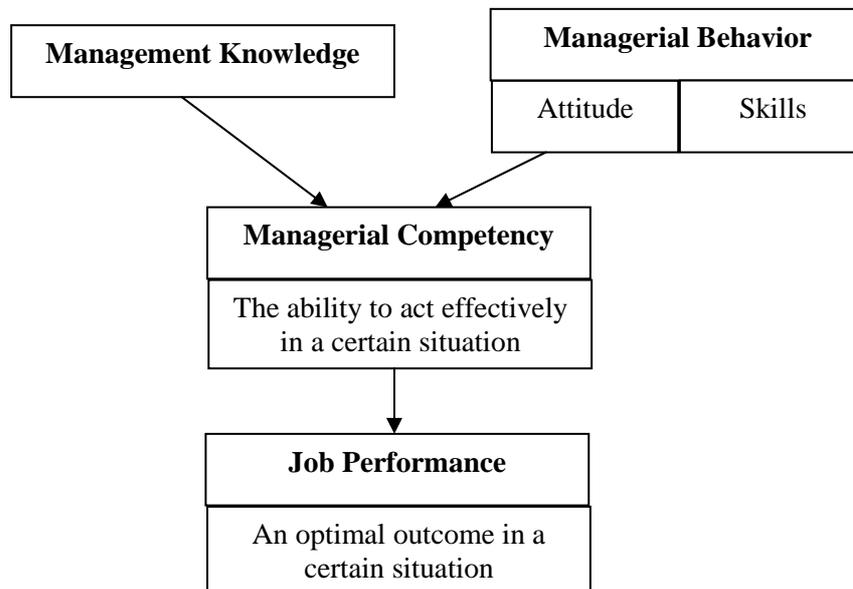

Fig. 1. The illustration of the managerial competence approach

3. Research Context

The importance of developing engineers as future managers is well recognized. As specialists argued in their studies the development of new engineering management talent is crucial to the survival and growth of their companies′ business (Thamhain, 1990).

Needless to say, Romania, as EU member state, is part of the European Higher Education Area. It started a significant restructuring process for adjusting the curricula according to Bologna Process. Initiated in 1999, the Bologna Accord, signed by the ministers of education of 29 European countries, explicitly recognized the importance of Quality Assurance in Higher Education. They established joint objectives for Quality Assurance as a means to ensure, measure, and improve the quality of European Higher Education with respect to making academic degree standards more comparable and compatible throughout Europe. Moreover, subsequent ministerial meetings, Prague (2001); Berlin (2003); Bergen (2005) and London (2007), increased the number of objectives for developing a coherent and cohesive European Higher Education Area by 2010.

Therefore, to ensure the compliance with European Higher /Education Area, the Romanian universities started, with the academic year 2005-2006, to offer new academic curricula. The technical universities have taken the appropriate steps towards the reduction of the studies from 5 to 4 years and restructuring the engineering education curricula, accordingly.

As specialists stated, the Management Department form ″Politehnica″ University of Bucharest (UPB) was involved in restructuring the academic curricula for engineering education (Scarlat & Purcarea, 2005; 2006). Consequently, grounded on the new approach of the educational environment, the Management Chair from the Management Department of UPB has started to restructure the academic curricula and syllabi.

In the pursuit of adopting changes, the team from Management Chair was focused on approaching two levels of technical education:

- Bachelor level, by offering a large number of subjects/courses in management area;
- Master level, by developing new post-university management programs addressed mainly to engineers.

The development of the framework for engineering education has taken into account a set of competences ensued by the post-university management programs. Table 1 presents a synopsis of the courses currently offered in management area by Management Department.

Table 1. The synopsis of managerial competency ensued
by post-university management programs

Managerial competency	Description	Types of courses offered
Communication competencies	The capacity to understand: • the human behavior • the human resource within the organization system • the relationships between employees and employees and organization management	Psychology & Sociology Communication & Negotiation Public Relations Human Resource Management Business Communication Management Information System
Leadership competencies	• The capacity to influence the human behavior toward accomplishing the organization objectives	Organizational Behavior Leadership
Professional competencies	The capacity to: • understand the business environment • develop and implement new management systems • think as an entrepreneur • assure and assign resources • develop and implement organizational projects • develop managerial processes based on customer oriented approach • integrate the business within the European economical-social system Etc.	Fundamentals of Management Strategic Management Project Management Marketing Marketing Research Marketing Management Services Management Quality Management Operations Management Business Ethics and Responsibility Entrepreneurship Etc.

4. Research Methodology

Deciphering the engineering managers' mind-set through a constant effort of research is a requirement of professional responsibility because this may yield clues about our community management practices. Although by no means exhaustive, the characteristics set for analysis – management knowledge and managerial behaviour – obviously yields clues about the engineering credential for becoming managers and leaders.

Based on this background, the authors have conducted a pilot study in an attempt to investigate which managerial competencies are currently being possessed by engineers as part of their management work. The target group was consisted of graduates of technical higher education which are involved in the post-university management programs at the Management Department form ″Politehnica″ University of Bucharest UPB). Since many of

the master students were employed as engineers with managerial functions within a variety of local organizations, it was felt that these students and their perspectives would provide a suitable sample for a pilot study.

Under these circumstances, the empirical research has addressed the following objectives:

- to investigate to what extent engineers with managerial responsibilities are well trained for certain managerial functions.
- to develop recommendations for enhancing the curricula of the engineering higher education.

Variables Measurement

Assessing the managerial competency of engineering managers requires structuring the characteristics of this process. The authors have set out two types of variables: nominal and attitudinal. The nominally scaled variables are consisted of demographic, situational, and educational information. Addressing the problem of measuring the managerial behavior for engineers that took on managerial responsibilities involves designing multiple-item scales. As researchers argued, developing a multi-item scale is a complex procedure due to the abstract nature of the characteristic that has to be measured (Aaker, Kumar, & Day, 2001). As a summary, Table 2 shows the structure of relevant variables of the research.

The qualitative questions were measured using a five-point Likert scale, whereby 1 - Strongly Disagree, 2 - Disagree, 3 - Tend to Agree, 4 - Agree, 5 - Strongly Agree. Each respondent was asked about his/her degree of agreement or disagreement concerning the items designed to assess the managerial behavior.

The process of developing the content of each item concerning the research variables assessment has drawn knowledge from the relevant scientific literature. The specialists argued in their studies that engineers who aspire to become managers have to pay carefully attention to the problem of attitude toward becoming an effective engineering manager (Chang, 2005).

Thus, *the attitudes dimension* was measured by asking respondents to express their general opinion regarding the following items: engineering management, power base, and assertiveness. The items assessed the extent to which engineering managers are willing to apply management functions of planning, organizing, leading, and controlling in their work. Furthermore, items were measured the degree in which engineering managers must nurture the ability build personal power by technical know-how, experience, and networking. Also, according to Hoffman (1989), the engineering managers should demonstrate the ability to be assertive in exercising judgement and making decisions.

Developing the items aiming at assessing *the skills dimension* has been taken into account important research insights about the fundamental differences between the work done by engineers and that performed by managers (Morrison, 1986). Under these circumstances, the skills level was measured using a hybrid three-point Likert scale, whereby 1 – Unsatisfactory Skills, 2 – Good Skills, 3 – Great Skills. Examples measured the extent to which respondents were able to *behave as professionals* in the field, such as honesty and individual integrity, the ability to make tough decisions, and the willingness to enhance personal professional competence, Also, as Mulcahy (2005) stated, the professional responsibility require to constantly contribute to the development of the management knowledge base by performing research to discover best practices.

Table 2: The map of research variables

Research variables		Conceptual description	Operational description
Nominally Scaled Variables	Demographic variables	Gender	Feminine, Masculine
		Age	Age levels
		Time from graduation	< 1 year 2-5 years 6-10 years > 10 years
		Managerial experience	< 1 year 2-5 years 6-10 years > 10 years
	Situational variables	Managerial level	Strategic Functional Operational
		Organization type	Budgetary Private capital Public capital
		Organization size	Small Medium Large
	Educational variables	Management knowledge	Different management-type courses
Attitude Rating Scaled Variables	Managerial behavior	Attitudes dimension	Engineering management Power base Assertiveness
		Skills dimension	Professional responsibility Interpersonal communication Entrepreneurship

Interpersonal communication and entrepreneurial skills were assessed developing items grounded in the work of the distinguished researcher Badawy (1995). Examples included the extent to which engineering managers are flexible in dealing with a diversity of issues and people. Also, the items measured the entrepreneurial spirit of respondents by evaluating the willingness to take new risky approaches in making managerial decisions.

Data Collection & Analysis

In order to examine and assess managerial competencies posses by engineering managers involved in different management programs of postgraduate studies of the Management Department from (UPB), it was performed a questionnaire-based research. The questionnaire had an adequate pattern, starting with questions to evaluate the engineering managers' management knowledge base and their managerial behaviour, and finishing with questions for respondents' demographic characteristics. The questionnaire was distributed to 152 postgraduate engineering students who took on managerial responsibilities in their work. Only 80 respondents have filled the questionnaire.

Statistical methods were applied in order to create demographic profiles of the sample, and examine the managerial competencies of the respondents. The central tendency was calculated taking into account the way in which the variables were measured: the modal group for nominal scale and arithmetic mean for interval scale (table 3 and 4).

Overall, the structure of the sample in terms of gender was rather unbalanced (20% women and 80% men). Respondents' age was mostly of 30-35 years (45 %); 30% were up to 40 years; 15 % were of 41-45 years, and only 10 % were older than 46 years.

From the managerial experience standpoint, 40 % of the respondents were less than one year experience as engineering managers, 20 % was between 2 to 5 years, 20 % were between 6-10 years experience, and other 20 % were more than 10 years experience.

Most of the respondents graduated 10 years ago (55 %), and only 5% of the sample was mostly less than one year experience as engineer.

The structure of the sample in terms of management levels was as follows: 20% of respondents from strategic level and 80 % from operational level.

The respondents came from different organization types such as: 15 % form budgetary organization, 55 % from private capital, and 30 % from public capital organization. From the organization size point of view, 25% of respondents have worked in small enterprises with less than 50 employees; 20 % in medium-size enterprises; and 55 % have employed in large organizations with more than 250 employees.

Table 3 The key attitudes for managerial behaviour assessment

No.	Predictors for success	Arithmetic mean
	An engineering manager should have:	
1	*An engineering management mindset*	**4.5**
	• to be capable to think in terms of management functions	4.55
	• to be willing to work with people	4.3
	• to be a communication facilitator	4.65
2	*A power base formation*	**3.71**
	• to be willing to take on challenging tasks	3.75
	• to capture the opportunities to exercise power	2.65
	• to be ready for promotion to managerial positions	3.75
	• to nurture the ability to build personal powers	3.95
	• to cultivate a broad business relationships	4.45
3	*Assertiveness*	**4.17**
	• to be informed of the best practices in the field	4.45
	• to be assertive in exercising judgment and making decisions	4.4
	• to be aware of the best success factors and other benchmarks in the field	4.45
	• to be proficient in resolving technical conflicts and people problems	3.4

As far as the theoretical engineering education, the respondents weighed the following courses′ subjects as the highest level of significance: Interpersonal communication (85%); Management Knowledge (65%); Technology Knowledge (60%); Informatics (55%). Beside these, the medium weighed courses′ subjects were: Economics (75%) and Legislative (65%).

As reflected in their responses, the graduates of the higher engineering education with managerial responsibilities (engineering managers) seem not to be experts in the following management areas: Process Management, Financial Management, Quality Management, Stress Management, Risk Management, and Environmental Management.

It is also interesting to note that respondents seem to possess adequate knowledge in broader management areas, such as: Product Management (55%); Customer Relationship Management (50%); Consumer Behaviour (50%); Business Communication (65%); Motivation & Influence Techniques (60%).

Table 4 The key skills for managerial behaviour assessment

No.	The managerial skills developed by the engineering education	Arithmetic mean
1	*Professional Responsibility*	**1.64**
	• to behave honesty in interpersonal relationships	1.2
	• to be guided by a set core of principles	1.5
	• to enhance the professional life	2
	• to be aware of professional responsibilities	1.9
	• to be creative in handling problems	1.6
2	*Interpersonal Communication*	**1.53**
	• to facilitate the exchange of information	1.7
	• to be capable of oral and written communication	1.95
	• to diplomatically deal with people	1.3
	• cross-cultural communication capacity	1.25
	• teamwork capabilities	1.45
3	*Entrepreneurial Spirit*	**1.47**
	• capability to take on initiatives	1.5
	• capability to identify and capture new opportunities	1.45

Throughout the engineering education, the respondents were exposed to the major aspects other management courses, such as: Project Management, Sales Management, Merge & Acquisition, Strategic Management, Marketing, and Leadership. From the theoretical standpoint, the respondents seem to understand well the value of *management knowledge*, but when it comes to practice there are a lot of difficulties. In other words, a true understanding of *management knowledge* comes from comprehending how the different management concepts, tools, and techniques interact one each other to determine a cohesive whole.

5. Research Findings

The results of data analysis point out that respondents place great importance on the managerial knowledge within the theoretical engineering education. Although, most of the respondents graduated 10 years ago (55%), they seem to be ware of the usefulness of management courses within engineering education.

Even though, starting with the academic year 2005-2006, the engineering curricula and syllabi have evolved in accordance with the new requirements, the research results highlight the need for further improvements. From an educational perspective, the knowledge of management is almost as important as technology knowledge. Thus, the actual management education of engineers should be based on topics of top importance such as: *Process Management, Financial Management, Quality Management, Stress Management, Risk Management, and Environmental Management.*

The assessment of engineering managers´ attitude concerning the key predictors for success in managerial positions yields important clues about the cultural values of our society. As specialists in social sciences noted, an attitude is a learned predisposition to respond in a consistently favorable or unfavorable manner with respect to a given object (Fishbein & Ajzen, 1975). Moreover, attitude theory suggests that the ultimate behavior of a person is a function of three attitudinal components: affective component, cognitive component, and behavioral component. It is worth to be noted here that behavioral component refers to how one intends or expects to act toward someone or something (Kreitner & Kinicki, 2007).

Considering the research results (table 3), Romanian engineering managers ranked on the first place an engineering management mindset (4.5), followed by assertiveness (4.17), and the power base formation (3.71). These results emphasize the lack of power bases approach in the engineering education that include the lack of willingness to take on challenging tasks and the fear to capture the opportunities to exercise power. It becomes important, therefore, that engineering curricula should cover these aspects of managerial behavior through complementing the technology education.

Obviously, the attitude is an important part of managerial behavior, but the skill – the ability to act effectively – is also important. Therefore, the research has focused on assessing the managerial skills developed by engineering education (table 4). The data analysis reveals a serious lack of managerial skills occurring during the engineering education stage. The main types of managerial skills lacking from the technical education are professional responsibility, interpersonal communication, and entrepreneurship spirit skills.

Based on these, the technical higher education should be more oriented to practical approaches that enable engineering students to practice managerial skills until the preferred behavior becomes second nature. Indeed, many rules of thumb are derived from experience. A practical oriented educational environment assures students to learn the skills and capabilities to shape their's own attitudes, and to acquire the attributes needed to become good engineering managers. This requirement shows the necessity of changing the methods of teaching and promoting new methods that stimulate creativity and risk taking, professional responsibility, and teamwork. From this standpoint, the engineering education should make the best use of case studies method with examples from Romanian business community, and inter-disciplinary projects that stimulate communication and cooperation skills.

6. Concluding Remarks

This study provides a starting point for investigating the business and managerial competencies ensued by the technical higher education system. As the engineering education takes into account the analysis of management practices, the research results will play a significant role in improving the curricula of the technical universities. By appropriately redesigning the engineering curricula, the technical universities should seek to enable students to develop those managerial skills required by the business environment.

Considering the research results, there are several conclusions with respect to business and managerial competencies ensued by engineering education:

- There is a gap between the demand and offer with respect to managerial competencies ensued by the engineering higher education
- There is a lack of the systematic research of business environment in order to find out the changing requirements and provide feedback to the higher education environment.

In order to overcome these challenges the authors propose several recommendations based on the research results:

- The management education of engineering students has to complement technology education by adequately consider new courses in management area as Process Management, Financial Management, Quality Management, Stress Management, Risk Management, and Environmental Management. Therefore, it becomes important to offer a large number of management courses to engineering students. Innovative approaches in the field are needed to help engineering students to understand the new concepts and be aware of the dynamics in the business environment, advancement of technology, and competition in the marketplace.

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- The technical universities must incorporate new teaching methods, successfully (e.g. the use of case studies method is an effective means of introducing students to business situational learning; and experiential learning through group projects that encourage students to experiment).

- The technical universities should carefully take into consideration the development of innovative networks between academic environment and business community. These networks provide an excellent context for exchanging ideas and learning by sharing knowledge and experiences. More specifically, developing an interconnected educational environment require to attract experts from business community to give academic lecturers. When properly done, both parties – academic and business – learn from each other, and the students have a significantly learning experience.

Based on the research conclusions and recommendations, the authors have placed great emphasis on business cases development that focuses on the challenges of engineers as managers and leaders.

Another authors' concern is keeping engineering students abreast of the new developments in management fields. Theoretical improvements will be incorporated in the management courses with the aim to properly prepare engineering students to fulfill managerial responsibilities and acquire useful managerial competencies to meet the challenges in the new millennium.

Even thought, this study has several shortcomings such as sample selection, industry, and number of respondents, further research will be performed in order to capitalize on these findings and provide feedback to the technical university decision makers.

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