

## The necessity of developing the economic engineering specialization in the current context of Romania's economic structure



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### ABSTRACT

The reasons behind this research are those that have led to the need for a modern system of qualifications in Romanian higher education, in such a way that this system becomes convergent with the recommendations of the European Commission and with the imperatives of the Bologna process, correlated with the requirements and evolution of the labor market in the current stage of Romania's economic structure. The research method that responds best to this approach is the case study. It answers questions such as "how" and "why" and is appropriate for a situation in which the complexity of labor market phenomena, in the context of Romania's economic structure, is unpredictable. The case study architecture allows us to determine the questions of the case, the hypothesis, the analysis units, the preliminary theories about the economic engineering specialization, the occupations of economic engineers on the labor market, as well as the matrix of knowledge from different disciplines that form the professional and transversal competencies for these occupations. Last but not least, it enables one to manage data collection, data analysis, and draw conclusions about the economic engineering specialization. Practically it looks at the innovation of the engineering profile, respectively that of the profession of economist engineer in the electric, the electronic and the energetic field. This paper provides support for further research as regards the continuous training of economist engineers in the field of engineering and management studies.

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### 1. Introduction

A modern system of qualifications in the Romanian higher education represents, in fact, the innovation applied to the old system, through the elimination of former qualifications that became inappropriate with the disappearance of certain economic structures, especially of industry, which used to be the main domain of activity for engineers. Innovation involves a modern system that would be convergent with the recommendations of the European Commission and with the imperatives of the Bologna process, correlated with the requirements and evolution of the labor market. The mechanisms of such innovation can be considered the university professors, students and the representatives of the economic and social environments, constituted in consortia of the

"university-enterprise" type. This mechanism must operate in accordance with the structure of the undergraduate study areas.

The Consortium of "Engineering and Management", in accordance with the structure of the undergraduate university domains, should have the role of validating or fine-tuning the descriptions of the qualifications included in the field of "engineering and management" studies. The profession (qualification) of an economist engineer in the electric, electronic and energetic field was described by experts, as a component of some projects.

The chance for Romania's national economy to survive and return to a normal situation is the use of a National Qualifications Framework in Higher Education (CNCIS), which is, in fact, the academic value that can facilitate such a chance.

The return to a normal situation of the national economy, which is now in a state of subsistence, would ensure a normal development of the industry that could absorb the higher skilled labor force and would ensure the improvement of the population's living standard.

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The ever-changing national labor market needs a more accurate description of the professions (highly qualified occupations, the obligation that is associated with the National Qualifications Framework in Higher Education, but also with the requirements of the international labor market.) "The use of CNCIS is measured by that it is an integral part of the National Qualifications Framework and has no usefulness outside it".

The National Register of Qualifications in Higher Education is a computerized application organized in the form of a national database that includes all the qualifications awarded by higher education institutions in Romania, being also a working tool for universities, students, candidates, social partners.

The foundation of the curricula on competences and learning outcomes, both at bachelor and masters level, is the premise of a qualification framework designed as a basic tool in the development of the "EHEA Higher Education Area", which was actually assumed by the Ministers of Education in the signatory states of the Bologna Process. The "qualification frameworks" represent important tools for achieving comparability and transparency within the EHEA and for facilitating the mobility of learners both within higher education systems and among them. In the same line of thought: "qualification frameworks play a key role in the development of EHEA". A qualification framework encompasses all qualifications in a higher education system - or from an entire education system if that framework is developed for that purpose. It shows what a person who learns, knows, understands is able to perform on the basis of a given qualification, shows the results of learning for a specific qualification, and indicates how different qualifications in the system of undergraduate or higher education enable learners to move among qualifications, or The development of national qualifications frameworks is an important step towards the implementation of lifelong learning. We intend to be implemented and prepared for self-certification according to the general framework for qualifications for the European Higher Education Area by 2012. This will require sustained coordination at the level of the European Higher Education Area and the European Qualifications Framework for Lifelong Learning".

The authors have completed some researches on the issue referred to above, relevant in terms of grounding the problem approached, which were published in professional journals and presented at international conferences (Rada et al., 2016; Măgdoiu and Rada, 2013; 2014; 2016; Măgdoiu et al., 2014; Rada and Rada, 2018a;b)

The labor market in the current Romanian economy has gone through constant changes, and the jobs available for engineers with knowledge of economic issues have become a necessity. Their multidisciplinary training enables them to acquire professional and transversal skills in accordance with the requirements of the labor market. Economists in general, and economist engineers in

the electric, electronic and energetic field in particular, have access to occupations, others than that of entrepreneur, in the most diverse departments of an enterprise, from research, development, design, production, marketing, marketing, as well as occupations in secondary education.

## 2. The research method

The research method chosen for this approach is the "case study strategy" (Yin, 2005); we opted for it since there is little control over the events studied, as attention was directed to the phenomenon of economic engineering, in general, and to electrical engineering, in particular, to the need for innovation - to develop it in order to obtain the high-level multidisciplinary qualification for the future specialists in this field, who are thus enabled to access occupations in the increasingly internal and international labor market, as they demonstrate complex technical abilities along capacities related to the economic domain. Innovation in this form of engineering refers to preparing engineers to meet the challenges of an economy without a stable economic system. By promoting, organizing and conducting undergraduate studies in the field of fundamental engineering, engineering and management, under the terms of the law, engineers become economist engineers, able to cope with current challenges. This method responds to the initial "how" and "why" questions and presents both advantages and disadvantages.

The use of this method responded to our intention to deal with the contextual conditions of innovating in the field of engineering in its structure and with the development of economic engineering for the purpose of helping students find employment on the continuously changing labor market. Because the phenomenon and the context are not always differentiable in real life, data collection and analysis strategies have been used.

### 2.1. Study questions

The first critical component of the research design for the case study strategy is represented by the study questions. Since they are of the "how" and "why" type, they are more likely to require an explanation, and may involve the use of case studies, histories and experiments as favorite strategies. The case-study strategy allows us to find out how and why it is necessary to innovate the field of engineering in its structure, without starting from the evaluation of archival data or a survey. So these types of questions provide an important clue as to the most relevant strategy to use; therefore, they have been set as study questions:

1. How and why is it necessary to develop the field of economic engineering in the electric, electronic and energetic domains, in the current context of the Romanian economy?

2. How is innovation in the structure of engineering actually performed?
3. Why is electrical engineering in the electric, electronic and energetic domain a result of innovation in the structure of engineering?

## 2.2. The hypothesis

The second component of the case study design is the hypothesis of the study, focusing on the issue of the necessity to innovate engineering in its structure for the purpose of developing economic engineering as a specialty and also forms economist engineers as specialists prepared to cope with the increasingly sophisticated challenges of the labor market. The research started with the question "How and why is it necessary to develop economic engineering in the electric, electronic and energetic field in the current state of the Romanian economy?", So the questions "how" and "why" capture the essence of what needs to be learned and lead to the choice of the case study as an appropriate strategy. Such questions do not indicate what should be studied, leaving to the researcher the formulation of the hypothesis whereby he/she will advance in the right direction. Thinking focuses on the idea that engineering must be innovated in its structure, by developing a multidisciplinary form of engineering in the economic, electric, electronic and energetic domain, which would meet the complexities of the ever-changing labor market demands.

Besides the fact that the hypothesis reflects an important theoretical aspect (that is, it is necessary to innovate the engineering in its structure), it also indicates where to look for relevant evidence (to determine to what extent the economic engineering in the electric, electronic and energetic field is the result of innovating engineering in its structure. The established hypothesis is as follows:

- If economic engineering in the electric, electronic and energetic field is needed in the context of the current state of the Romanian economy, being called to solve the challenges of the constantly changing labor market, then the engineering in its structure must be innovated by bachelor degree programs that will ensure the accreditation of the specialization of the economic engineering in the electric, electronic and energetic field and implicitly the profession of multidisciplinary trained economists.

## 2.3. The analysis units

The next component of the research design, the third one actually, refers to the analysis units, which are related to the fundamental problem of defining the "case." This case does not refer to individuals or groups of individuals, where an individual represents the case studied and at the same time the primary analysis unit, but it refers to the phenomenon of the necessity to develop the

specialization of economic engineering in the electrical, electronic and energetic field at the present stage of the Romanian economy, in order to solve the challenges of a continuously changing labor market; it also refers to a university that provides degree programs in the field mentioned above, which cannot be very well defined as an individual. This is a case study on decisions, programs, implementation processes and changes in the engineering structure. Such topics, and thus implicitly the economic engineering in the electric, electronic and energetic field, are not very easy to define with regard to the starting and ending points of the "case".

The study on such topics may reveal: "a) variations in the definition of decisions, programs, implementation processes or changes in the engineering structure, and b) their components that existed before their formal nomination" (Yin, 2005). Therefore, in this study, the delimitation conditions a) and b) are taken into account in defining the conditions for the analysis.

The establishment of the analysis unit and, therefore, of the case, is related to the way in which the initial study questions were formulated, i.e., it was intended to address as "unit of study analysis" the development of economic engineering in the electric, electronic and energetic domain in the current context of the Romanian economy, through the innovation of the structure of engineering, the result of this development being the specialization of the economic engineering in the electric, electronic and energetic field, and implicitly the formation of economist engineers, completing university studies in the field, both actions being aimed at answering the challenges of the ever changing labor market. The selection of the analysis unit was made after the primary research questions had been specified. At the time of setting up the analysis unit it was not regarded as being definitive, which allowed for the possibility, as with other aspects of design, for it to be reconsidered as a result of discoveries made during the subsequent stages of the study.

### 2.3.1. The primary analysis unit

The primary analysis unit is the development of economic engineering in the electric, electronic and energetic field in the current state of the Romanian economy.

### 2.3.2. The contextual analysis unit (the existence of the case)

The contextual analysis unit is the very existence of the case, namely: the necessity of innovating engineering in its structure by means of undergraduate studies programs, so as to obtain new specializations and, implicitly multidisciplinary specialists, in the current state of the Romanian economy.

### 2.3.3. The embedded analysis unit

The embedded unit includes economic engineering in the electric, electronic and energetic field as a result of the innovation of engineering in its structure, by means of undergraduate university studies, in the current state of the Romanian economy.

### 2.3.4. Linking data to hypotheses

The fourth component of the case study design anticipates the data analysis stage and is usually little discussed as part of case studies, but the research design should help build solid bases for this stage of the investigation. There is no clear explanation of how to link data to hypotheses, although this can be done in several ways. The approach chosen by us is a promising approach for case studies, i.e., the pattern matching approach, described by Yin (2005). This technique involves "the use of a pattern matching logic" (Yin, 2005), which compares a pattern established on empirical bases with an anticipated pattern (or with more alternative predictions), as shown by Trochim (1989). In this case, if the pattern established on empirical bases (i.e. "the necessity of innovating engineering in its structure through bachelor studies so as to generate new specialists, and implicitly train multidisciplinary specialists, in the current state of the Romanian economy"), coincides with the anticipated (predicted) pattern (i.e. "Achieving the development of economic engineering in the electric, electronic and energetic field in the current state of the Romanian economy", in order to solve the challenges of a continuously changing labor market); the results can contribute to the consolidation of the specializations required on the ever-changing labor market. In this case the patterns are related to the dependent and the independent variables defined above, namely the predicted pattern with respect to the independent variable is defined before the data collection stage, and the information obtained in this case can be related to the theoretically determined hypothesis.

### 2.3.5. Criteria for data interpretation

The fifth component of the case study design allows for the interpretation, by comparison, of at least two alternatives. These alternatives depend on researchers' understanding of the conditions under which new findings of research related to the economic engineering in the electric, electronic and energetic domain may be useful in achieving the innovation of engineering in its structure through undergraduate university studies, with the view of answering the challenges of an ever-changing labor market. It might be worth pointing out here that often people believe that research serves only itself, "without satisfying any practical need" (Yin, 2005).

The pattern matching technique is also valid when it comes to an explanatory study, the patterns being related to the independent variables, in this case: the necessity to innovate the engineering in its structure through bachelor studies, so as to initiate new speculations and implicitly train specialists with a multidisciplinary formation, in the current stage the Romanian economy. The patterns can also be related to the dependent variables, in our case: the development of economic engineering in the electric, electronic and energetic field, in the context of the current state of the Romanian economy. This technique would prove equally relevant when the study is descriptive, as long as the anticipated (predicted) pattern related to specific variables is defined before the data collection stage, in this case: the development of economic engineering in the electric, electronic and energetic field, in the current context of the Romanian economy, in order to solve the challenges of the ever changing labor market.

Being the last component of the research design, the criteria anticipate the data analysis stage. The data obtained through the chosen strategies and techniques represent a constant challenge to perform a quality analysis; this aspect led researchers to pay particular attention to all the evidence. Evidence was presented objectively while an appropriate interest in the exploitation of alternative interpretations was also manifested (Yin, 2005). For the interpretation of the findings, combined criteria were used, generally applying the logical models: "The logical model deliberately stipulates a complex chain of events over time. These are included in repeated "cause-effect-cause-effect" patterns (Yin, 2005). That is, the dependent variable from an initial stage "achieving the development of economic engineering in the electric, electronic and energetic field, as part of the current context of the Romanian economy" becomes independent variable at a later stage "the innovation of engineering in its structure by means of undergraduate university studies, with the view of obtaining new speculations, and implicitly specialized persons with a multidisciplinary training, able to perform efficiently on the current stage of the Romanian economy, and prove "able to cope with the full challenges of the ever changing labor market". The logical model implies matching the empirically observed events with the theoretically foreseen elements of "developing the specialization of economic engineering in the electric, electronic and energetic field" in order to generate specialists able to cope with the complex challenges of the ever-changing labor market in the current state of the Romanian economy.

## 2.4. Preliminary theories

After analyzing the five components of the design, a preliminary theory related to the topic of the study should be developed. Applying the practice of developing the theory before collecting the data (evidence) marks the difference between the case

study as a research method and other similar methods. Some of these, for instance ethnographies and the grounded theory deliberately avoided specifying theoretical hypotheses at the beginning of the investigation (Yin, 2005). This situation can induce mistakes, as they can be taken for the case study. It can be thought that the so-called "confusion" with the case study allows for the immediate switching to evidence collection and the very early reaching of "field contacts". The serious error consists in creating relevant field contacts without the understanding or the theorization of the object being studied.

In the present case, the development of theory as part of the design stage is essential for the purpose of the investigations; we proposed a theory on the development of economic engineering in the electric, electronic and energetic field, regarded in the current context of the Romanian economy. It shows why the mere replacement of the old structures of engineering (e.g., mechanical engineering, electromechanical engineering, metallurgical engineering, etc.) was not enough to innovate engineering in its structure, in the current context of the Romanian economy; it also indicates why the mere elimination of such specializations from university studies does not solve the increasingly complex and ever changing demands of the labor market.

The first theorization is that of the primary analysis unit that includes: "developing the field of economic engineering in the electric, electronic and energetic domain, in the current context of the Romanian economy". Economic engineering in the electric, electronic and energetic field is the result of innovating engineering in its structure, due to the increasingly demanding requirements of the complex and ever-changing labor market for specializations in the field of multidisciplinary engineering and the need for specialists with multidisciplinary training, able to face the aforementioned challenges. Economic engineering in the electric, electronic and energetic fields is, just like all the other engineering specializations (systems engineering, computers, automation, electrical systems, electronics, telecommunication, etc.) part of the fundamental domain of "engineering sciences", while it is also included in the domain of "engineering and management studies". This field of study is relatively new and has been created through a symbiosis of the business environment with the Romanian higher education institutions, precisely for the needs presented above. The mission for whom it was created "is to increase the level of training, evaluation and certification of the quality of managerial activity and, in this regard, to improve managerial education in all its forms. It also promotes economic engineering education as an interdisciplinary form of managerial education and promotes the profession (occupation) of economist engineer" (AMIER, 2018), with the view of "Establishing a set of relationships between the economic environment, universities and research

institutions, with managerial preoccupations, so as a professional, managerial dialogue, with mutual benefits, will be facilitated. Organizing activities such as: training, consulting, documentation, technology transfer, auditing, postgraduate courses etc. leading to the formation and development of a managerial culture, the improvement of the managerial act, in order to increase the competitiveness of the enterprises, is also an aim had in view by the specialists in the field. Promoting excellence in managerial activity and in the preparation of economic engineering. Initiating and developing links with other professional organizations in the country and abroad with similar or converging activities and objectives" (AMIER, 2018).

Of course, the expected answer came from the university environment, by the action of designing and implementing the undergraduate study program of the economic engineering specialization in the electric, electronic and energetic field; also for domains such as mechanics; forestry, food industry, etc., as part of the field of engineering and management studies, belonging to the larger domain of fundamental engineering sciences. Graduates of such bachelor degree studies would be engineers with the specialization, in our case, of economic engineering in the electric, electronic and energetic field, who have completed over four years of theoretical studies and practical training and acquired the number of transferable credits for the necessary professional and transversal skills demanded by the ever-changing labor market. The structure of their training includes 55% of disciplines related to technical training, 35% subjects related to economic training and 10% subjects associated with legal training.

The competencies offered by the specialization of economic engineering in the electric, electronic and energetic field to the university graduates, with a university diploma degree are the following:

#### **a. Professional skills**

"C1 Making calculations, demonstrations and applications in order to solve engineering and management-specific tasks, based on the knowledge pertaining to the fundamental sciences";

"C2 Association of knowledge, principles and methods from the technical and economic sciences of the field with graphic representations, so as to be able to solve specific tasks";

"C3 Planning, programming and self-management of enterprises, especially SMEs, as well as the planning, programming and self-management of associated logistics networks; planning, programming, conducting and tracking production";

"C4 Designing economic and financial flows at the business level, managing the economic and financial phenomenon";

"C5 Quality technical and technological design of processes related to the electrical, electronic and energetic structures and systems; technical and technological design of processes in the electrical,

electronic and energetic industry, in specific quality conditions";

"C6 Auto management and self-control of the companies and processes specific to the activity in the field of electric, electronic and energetic domain; project and enterprise management in the electric, electronic and energetic domains"

#### **b. Transversal competences**

"CT1 Responsible application of the principles, norms and values of professional ethics in the performance of professional tasks and identification of the objectives to be achieved, of the available resources, of the stages of work, of the execution times, of the related implementation deadlines and the related risks".

"CT2 Identification of roles and responsibilities in a multidisciplinary team and the application of effective relational and work techniques within the team"

"CT3 Identification of opportunities for continuous training and efficient use of information resources, communication resources and assisted training resources (Internet portals, specialized software applications, databases, on-line courses, etc.) both in Romanian and in an international language".

All competencies, both professional and transversal, as well as the individual knowledge required for their acquisition, have been established in the Consortium of Engineering and Management, formed by the business environment and the university environment in Romania.

The occupations on the labor market in the present stage of the structure of the Romanian economy are those set out in the National Register of Qualifications in Higher Education in Romania, namely:

1. Economist engineer;
2. Project manager;
3. Economist adviser in trade and marketing;
4. Specialist in public administration;
5. Inspector specialized in public administration;
6. Assistant Director - Higher Education;
7. Quality Assurance Engineer;
8. Quality assurance reviewer
9. Logistics engineer;
10. Administrator (higher education);
11. Human resources inspector (higher education);
12. Human resource officer (higher education);
13. General, social, non-entrepreneurial, enterprising entrepreneur.

These competences present the requirements for the image of the economic engineering specialization in the field of electric, electronic and energetic domain and also the image of the graduate student in terms of qualification level. It should be pointed out here that the new "status of the bachelor of a technical domain must be directed towards multidisciplinary training".

The following theorization is made for the contextual analysis unit, which is the existence of the case, namely: the necessity of innovating engineering in its structure through bachelor studies, aimed at establishing new speculations, implicitly develop specialists with multidisciplinary training, able to perform in the present context of the Romanian economy. Taking into consideration the fact that, apart from the legal provisions in Romania regarding the undergraduate studies, starting with 2005, the substantiation of the study programs on competences and learning outcomes as the premise of a qualification framework designed as a basic tool in the development of the European Space of Higher Education (EHEA) has become an obligation assumed by the Ministers of Education in the signatory states of the Bologna Process, the bachelor's degree program in contemporary economics, where the labor market is constantly changing, the need for qualifications can be satisfied by hybridizing some segments of the sciences .

With the Validation, by the Consortium of Engineering and Management, of the Bachelor's degree in Economic Engineering in the Electric, Electronic and Energetic Domain, the Department of Engineering and Management, within our Faculty, has analyzed the professional competences and transversal skills that the economist engineer must acquire until graduation, and defined the possible occupations to start from such needs. Together with the members of the Department of Engineering and Management, on the occasion of a department meeting, the opportunity of the subjects, included in the curriculum for the specialization Economic engineering in the electric, energetic and electronic field, the sequence over time and the logic of teaching the disciplines over time, the contents of the disciplines and themes to be developed during courses seminars, laboratory works, etc. were analyzed.

Once the competences matrix was established through a profound analysis of the description of the profession (occupation) of an economist engineer in the electric, energetic and electronic field, that had to be in line with the National Qualifications Framework in Higher Education, the members of the department established the curriculum of the University Bachelor Studies in the fundamental field of engineering sciences; the study domain: Engineering and Management, Specialization: Economic Engineering in Electric, Electronic, and Energetic Domain. The program takes into account the improvement of the degree upgrading, the evaluation and the certification of the managerial activity quality and in this respect the improvement of managerial education, the promotion of the economic engineering education as a form of interdisciplinary education of a managerial nature and the promotion of the profession (occupation) of economist engineer.

The last conceptualization refers to the embedded unit comprising economic engineering in the electric, electronic and energetic field as a result

of innovating the structure of engineering through undergraduate studies, in the current state of the Romanian economy. It refers to the capability of the undergraduate degree program for economic engineering in the electric, electronic and energetic domain to provide the economist engineers with some minimal performance requirements for competence assessment such as:

1. Solving and explaining problems of medium complexity, associated with fundamental disciplines, specific to engineering sciences.
2. Develop a professional project specific to Engineering and Management, using specific software and databases.
3. Designing economic-financial processes, at the business level, for a given situation.
4. Elaborating a technological project on the electrical, electronic and energetic system processes.
5. Elaborating projects that follow the management of enterprises from the electric, electronic and energetic domain.
6. The responsible achievement, in conditions of qualified assistance, of projects aimed at solving problems specific to the field, with the correct assessment of the workload, the available resources, the time required to complete the tasks and the risks involved, observing the conditions of deontological and professional ethics in the field as well as requirements related to health and safety at work.
7. Writing a paper/completing a project as a leader in a multidisciplinary team and distributing with responsibility specific tasks to the subordinates, adopting a positive attitude and demonstrating respect towards the team members.
8. Elaborating and supporting, in Romanian and in an international language, a personal development plan using various sources and information tools.

### 3. The gathering of evidence (data)

Evidence was collected from the following sources: documents, archives, interviews, sites, direct observation, participatory observation, respecting, in each case, the methodological procedures. In the process of data collection, the following priority principles were observed: a) multiple sources of evidence (two or more sources converging towards the same findings), b) a database (it is about the evidence gathered, not the final report and c) a logical succession of evidence (explicit links between the data collected, the questions raised and the conclusions reached)"(Yin, 2005). All sources represent helpful work and for this reason many articles and research methodology books for this study have been examined.

One of the most important sources of information for this paper has been the interview. Interviews were sometimes generated by the responsibilities associated with the activity of managing the bachelor's degree program. The results were recorded in the evaluation and monitoring documents, in reports presented to the management

of the Faculty and / or the University and the conclusions of these interviews have become confidential documents and are the property of the University. For this reason, they were not published (mentioned) in this study. The subjects of the university curriculum (curriculum and learning plan) in Romania for the Bachelor's Degree Program, Economic Engineering in the Electric, Electronic and Energetic Domain are as follows:

#### **Fundamental disciplines (F) 17.09%**

Mathematical Analysis I / I; Linear algebra, analytical and differential geometry I / I; Physics I / I; General Chemistry I / I; The use of computers I / I; Special Mathematics I / II; Programming of computers and programming languages I / II; Computer-aided graphics I / II; General Economics I I / II; Numerical methods for engineers II / III; General Economics II II / III.

#### **Domain-related disciplines (D) 39.32%**

Elements of Mechanical Engineering I / I; Technological methods and processes I / I; Electrical Engineering, I / II; Electrical and electronic measurements I II / III; Analog and Digital Electronics I II / III; Electrical Engineering II II / III; General Elements of Law II / III;; Electric machines II / IV; Electrical technologies II / IV; Analog and Digital Electronics II II / IV; Accounting II / IV; Finance and credit II / IV, Labor Law II / IV; Practice I II / IV; Electrical and electronic measurements II (optional) II / IV; Transducers and sensors (optional) II / IV; The basics of marketing III / V; General Management III / V; Business Law III / V; Static converters (optional) III / V; Electromagnetic converters (optional) III / V; Electro technical materials III / VI; Practice II III / VI; Inventiveness and industrial property (optional) III / VI; Quality Management IV / VII; International economic relations (optional) IV / VII; Financial Management (Optional) IV / VII; Human Resource Management IV / VIII.

#### **Specialization disciplines (S) 36.32%**

Technical drawing, I / I; Electrical equipment III / V; Reliability III / V; Basics of Assisted Design III / V; Negotiation techniques III / V; Electric drive systems III / VI; Microprocessor systems III / VI; Electrical installations III / VI; Strategic marketing III / VI; Economic and Financial Analysis III / VI; International Trade Law III / VI; Design of industrial electrical systems IV / VII; Electro-thermal engineering IV / VII; Advanced Production Systems IV / VII; Organizational Behavior IV / VII; Economic and commercial contracts (optional) IV / VII; Economic legislation (optional) IV / VII; Quality Engineering (optional) IV / VII; Labor and Human Resources (optional) IV / VII; Product Development Management IV / VIII; Basics of project management IV / VIII; Energy sources (optional) IV / VIII; Industrial Energy (Optional) IV / VIII; Microwave technologies (optional) IV / VIII; Use of electricity (optional) IV / VIII; The Management of Innovation

and Technology (optional) IV / VIII; Industrial Management (Optional) IV / VII; Practice for the elaboration of the bachelor project (optional) IV / VII; Foreign language I I / I.

### **Complementary disciplines (C) 7.20%**

Foreign language I I/I; Sport I / I; Foreign Language II I / II; Sport II I / II; History of science and civilization (optional) I / II; Multimedia and Internet Techniques (Optional) I / II; Professional Communication II / III; Foreign Languages III II / III; Sport III II / III; Philosophy (optional) II / III; Foreign Languages IV II / IV; Sport IV II / IV; Sociology (optional) III / V; English V (optional) III / V; English language VI (optional) III / VI.

The principles of building and developing the curriculum (study program and curriculum) BACHELOR UNIVERSITY STUDY PROGRAM - are based on: experience in curriculum design and application in Romania; international procurement in the field of curricular development; the imperative of coherent policies on building the curriculum at the level of the entire education system in Romania.

From the point of view of functionality, based on the analysis performed by the members of the department, who presented their subjects, as included in the curriculum, we had in view: the connection of different disciplines, as well as the categories of disciplines, to the current development of knowledge in the field, in consensus with the dominant aspects of this development; Setting up disciplines within the curriculum so that they respond appropriately to the set of skills required for a bachelor of science; linking curricular development with the amplification and diversification of the field of engineering sciences; that appropriate curricular answers can be given to questions such as: "What does the economist engineer need in exercising his professional role in the electric, electronic and energetic field? Is it legitimate to include disciplines, other than those related to the specialization, in the curriculum configuration of the specialization: economic engineering in the electric, electronic and energetic field? "

The curricular area represents a group of functional disciplines from the perspective of the competences required for the future graduate. Thus, the curriculum includes:

- kernel curricular areas, corresponding to the procedural dominants of the specific way of thinking. These procedural dominants are found in the fundamental disciplines: Mathematical Analysis; Linear algebra; Analytical and differential geometry; Physics; General chemistry; Computer use; Technical drawing; Special Mathematics; Computer programming and programming languages; Computer-aided graphics; General Economics I; Numerical methods for engineers; Professional communication; General Economics II;
- specialized curricular areas, corresponding to the expert in the fields of engineering and management, and reflecting the components of the specific way of thinking. The modes of thinking are generally found in the traditional delimitation of the specialty. However, in order to be functional, curricular areas reflect recent developments in the field and useful aspects related to the socio-professional insertion of economist engineers in the electric, electronic and energetic field. Specialized disciplines: Business Law; Electrical installations; Strategic marketing; Financial and economic analysis; International trade law; Practice II; Design of industrial electrical systems; Electro-thermal engineering; Advanced production systems; Human resources management; Quality management; Economic and commercial contracts (optional); Economic legislation (optional); International economic relations (optional); Financial management (optional); Quality engineering (optional); Labor and Human Resources (optional); Product development management; Project Management; Organizational behavior; Energy sources (optional); Industrial power (optional); Microwave technologies (optional); Use of electricity (optional); The Management of Innovation and Technology (optional); Industrial management (option); Practical activities for the elaboration of the dissertation thesis/diploma project;
- curricular areas of interference, which open up perspectives of the mode of thinking specific to transfer areas, by reference to different disciplines located in the epistemological proximity of the domain. The disciplines of the field are: Elements of Mechanical Engineering; Technological processes and methods; Electrical engineering I; Electrical and Electronic Measurements I; Analog and digital electronics I; Electrical Engineering II; General elements of law; Electric machines; Electrical technologies; Analog and Digital Electronics II; Accounting; Finance and credit; Labor Law; Practice I; Electrical and electronic measurements II (optional); Transducers and sensors (optional); Electric devices; Reliability; Basics of assisted design; The basics of marketing; General Management; Negotiation techniques; Static converters (optional); Electromagnetic converters (optional); Electric drive systems; Microprocessor systems; Electro technical materials; Inventiveness and industrial property (optional);
- curricular areas of functional culture that complement the specialized formation in economic engineering in the electric, electronic and energetic field, and ensure the functionality of the socio - professional integration, both as regards the labor market and the continuation of academic formation in the second cycle. The complementary subjects are: English I; Sports I; English Language II; Sports II; History of science and civilization (optional); Multimedia techniques and internet



(optional); English Language III; Sports III; Philosophy (optional); English Language IV; Sports IV; Sociology (optional); English language V (optional); English Language VI (optional), General Chemistry.

The typology of curricular areas and the relationships between them illustrate the framework generating the Educational Plan.

The analysis of the curriculum coherence - takes into account the degree of horizontal and vertical integration of the curricular areas and, within them, of the subjects to be studied. This principle involves two levels of correlation:

A. At the level of the plan, we relate to the correlation of study subjects to the vertical axis in order to ensure the formation of competences specific to the specialization of economic engineering in the electric, electronic and energetic domain; the subjects are also related to the horizontal coherence, in order to avoid overlapping and / or contradictions between related disciplines.

B. At the level of study programs, we refer to:

- Correlation (both horizontal and vertical) of the study subjects within the specialized curricular area, so that the competences specific to each discipline will harmonize with those of the other disciplines, in order to build the competences necessary for the specialization;
- Ensuring the complementarity of the contribution of the disciplines in building the competences targeted by the economic engineering specialization in the electric, electronic and energetic field. The disciplines that are not specific to this specialization are configured according to the socio-professional needs characteristic of this specialization. Thus, for example, as regards the content of the foreign language course, we focus on the functional component and the specialized language.

#### 4. Data analysis

Data analysis forms the chapter of the case study research strategy that focuses on examining, clarifying, tabling and testing the evidence. In other words, "the quantitative and the qualitative reorganization of data in order to address the initial hypotheses of a study" (Yin, 2005). In this respect we have encountered several difficulties, as the strategies and techniques that had to be used were not found in clearly defined bibliography. However, there have been three strategies, which rely on theoretical assumptions, and could be used in order to establish a framework based on alternative explanations, and in developing case descriptions based on these strategies "five techniques specific to case study analysis: pattern matching, constructing explanations, analyzing time series, logical models

and comparative synthesis" (Yin, 2005) could be used. The challenge in this case was that of completing a quality analysis, for it required careful attention paid to all evidence, not just the evidence presented here in Chapter 3. Objectivity was also aimed at when gathering data; interest in exploring alternative interpretations was demonstrated.

Since this approach is not as extended as, for instance, a doctoral thesis, all the data analyzed could not be included, especially since this research structure is among the most developed and difficult ones: there is no clue as to how evidence should be examined. In the analysis of this case, examinations were limited to the evidence from the analysis units that were established on the basis of the research hypothesis and which could demonstrate that economic engineering in the electric, electronic and energetic domain can be achieved by the innovation that is done in the structure of engineering. As part of the master degree program, a matrix is presented as follows which connects occupations in the labor market, skills, knowledge, disciplines and minimum performance standards in the current state of the Romanian economy structure:

#### **Occupations on the job market**

1. Economist engineer
2. Project manager
3. Economist adviser in trade and marketing;
4. Specialist in public administration;
5. Inspector specialized in public administration;
6. Assistant Director - Higher Education;
7. Quality Assurance Engineer;
8. Quality assurance reviewer
9. Logistics engineer;
10. Administrator (higher education);
11. Human resources inspector (higher education);
12. Human resource officer (higher education);
13. General, social, non-entrepreneurial, enterprising entrepreneur.

#### **Competences established by the "engineering and management consortium**

##### **a. Professional**

C1 Making calculations, demonstrations and applications in order to solve engineering and management-specific tasks, and graphs for solving specific tasks;

C2 Association of knowledge, principles and methods from the technical and economic sciences of the field with associated logistic representations, planning, programming and administrating production;

C3 Planning, programming and self-management of enterprises, especially SMEs, as well as the planning, programming and self-management of associated logistics networks; planning, programming, conducting and tracking production";

C4 Designing economic and financial flows at the business level, managing the economic and financial phenomenon;

C5 Quality technical and technological design of processes related to the electrical, electronic and energetic structures and systems; technical and technological design of processes in the electrical, electronic and energetic industry, in specific quality conditions;

C6 Auto management and self-control of the companies and processes specific to the activity in the field of electric, electronic and energetic domain; project and enterprise management in the electric, electronic and energetic domains.

#### **b. Transversal**

CT1 Responsible application of the principles, norms and values of professional ethics in the performance of professional tasks and identification of the objectives to be achieved, of the available resources, of the stages of work, of the execution times, of the related implementation deadlines and the related risks.

CT2 Identification of roles and responsibilities in a multidisciplinary team and the application of effective relational and work techniques within the team

CT3 Identification of opportunities for continuous training and efficient use of information resources and communication resources and assisted training resources (Internet portals, specialized software applications, databases, on-line courses, etc.) both in Romanian and in an international language.

#### **Knowledge necessary to acquiring competences**

C 1.1. Identification, definition and adequate selection, as part of the professional communication, of basic concepts, theories and methods associated with Mathematics, Physics, Chemistry, The science of materials, Mechanics, Resistance, Electrical engineering, Computer science.

C 1.2 Using the basic knowledge from the fundamental sciences in order to explain and interpret specific theoretical results, theorems, phenomena or processes specific to the domain of Engineering and Management.

C 1.3 Applying fundamental theorems, principles and methods for calculations and for solving well-defined problems, specific to the domain of Engineering and Management.

C 1.4 The adequate use of fundamental criteria and methods of evaluation for the identification, modelling, analysis and qualitative and quantitative appreciation of phenomena, processes and characteristic theories, as well as for the processing and interpretation of results of processes specific to the domain of Engineering and Management.

C 1.5 Elaborating models and professional projects through the selection and use of some consecrated principles, methods and solutions from the fundamental disciplines specific to the domain of Engineering and Management.

C 2.1. Computer-assisted combination and selection of concepts, theories and methods relative to the domain of Engineering and Management and operating with these in professional communication.

C 2.2. Using basic knowledge for explaining concepts concerning the computer-integrated design and implementation of tasks and processes specific to the domain of Engineering and Management.

C 2.3. Applying basic principles and methods for the design and implementation of specific activities related to engineering and management in conditions of qualified assistance, through the efficient use of the computer.

C 2.4. The adequate use of standard evaluation criteria and methods for the identification, modelling, analysis and interpretation of some computer programs and concepts' limits in the elaboration of design systems and the implementation of some activities specific to the domain of Engineering and management.

C 2.5 Elaborating professional projects specific to some activities from the domain of Engineering and Management, based on the selection and the use of some principles, methods and software applications.

C 3.1 Selection, formulation and use, in professional communication, of basic concepts, theories and methods specific to the management of SMEs.

C 3.2 Using basic knowledge in planning, programming and administrating production in order to explain and interpret processes and projects specific to the domain of Engineering and Management.

C 3.3 Applying basic methods and principles for the planning, programming and self-management of SMM enterprises in conditions of qualified assistance specific to the domain of Engineering and Management.

C 3.4 The adequate use of standard criteria and methods for the evaluation of the patrimony of a business in conditions of risk and uncertainty, in order to appreciate the quality, merits and limits of the economic-financial process.

C 3.5 Elaborating projects for foreseeing the economic-financial flows by using some principles and methods specific to the domain, in order to make the business profitable.

C 4.1 Defining basic methods and theories concerning the economics-related concepts in professional communication.

C 4.2 Using basic knowledge for the explanation and interpretation of methods and techniques in the economic evaluation of businesses from the field.

C 4.3 Applying principles and methods for the analysis, synthesis and mathematical modeling of economic-financial phenomena, in order to project economic and financial flows specific to the economic domain, in conditions of qualified assistance.

C 4.4 The adequate use of standard criteria and methods in order to evaluate the patrimony of a business of risk and uncertainty, in order to appreciate the quality, merits and limits of the economic-financial process.

C 4.5 Elaborating projects for foreseeing the economic-financial flows by using some principles

and methods specific to the domain, in order to make the business profitable.

C 5.1 Identifying and selecting words, concepts and methods from the technical and technological design of processes from the electric, electronic and energetic industry.

C 5.2 Using basic knowledge in order to explain and interpret some problems that might occur in the technical and technological design of processes from the electric, electronic and energetic industry, while observing the conditions imposed for quality.

C 5.3 Applying the basic principles and methods for the technical and technological design of processes from the electric, electronic and energetic industry in conditions of qualified assistance.

C 5.4 The adequate use of standard evaluation criteria and methods in order to appreciate the quality, the advantages and the limits of technical and technological processes from the electric, electronic and energetic industry.

C 5.5 Elaborating technical and technological designs relative to processes and activities from the electric, electronic and energetic industry, through the use of specific established methods and principles.

C 6.1 Identification, definition, selection and synthesis of basic concepts, theories and methods relative to the planning, programming and administration of processes specific to the electric, electronic and energetic domains and their adequate use in professional communication.

C 6.2 Identification, selection and synthesis of basic knowledge related to the management of the enterprise from the electric, electronic or the energetic field, as well as scheduling the activities aimed at explaining and interpreting specific situations, processes and projects in the domain-activity referred to above.

C 6.3 Applying basic principles and methods, specific to the management of enterprises from the electric, electronic and energetic domain, the scheduling of activities and the technical-economic documentation in conditions of qualified assistance.

C 6.4 The adequate use of standard evaluation criteria and methods in order to appreciate the quality, the advantages and the limits of management methods specific to the electric, electronic and energetic industry.

C 6.5 Elaborating technical and technological designs relative to processes and activities on an enterprise from the electric, electronic and energetic industry, as regards the management of such systems.

### **Subjects from the curriculum, which provide knowledge and abilities for the formation of competences**

#### ***The subject C1***

Mathematical Analysis; Linear algebra, analytical and differential geometry; Physics; General Chemistry; The use of computers; Special Mathematics; Programming of computers and

programming languages; Computer-aided graphics; General Economics I; Numerical methods for engineers; General Economics II.

#### ***The subject C2***

Electrical Engineering I; Electrical Engineering II; Elements of Mechanical Engineering; General elements of Law; Electrical machines; Analog and Digital Electronics; Accounting; Finances and credit; Work law; Basics of marketing; General management; Business law; Quality management; International economic relations (optional); Financial management (optional); Human resources management; Economic and financial analysis.

#### ***The subject C3***

Professional communication; General management; Business law; Quality management. International economic relations (optional); Financial management (optional); Human resources management; Philosophy (optional); Sociology (facultative); Technical drawing; Electrical equipment; Reliability; Basics of assisted design; Negotiation techniques; Strategic marketing; Economic-financial analysis; Corporate behavior; Commercial and economic contracts (optional); Economic legislation (optional); Quality engineering (facultative); The science of work and human resources (facultative); The management of product development; The management of innovation and technology (optional); The basics of project management; Industrial management (optional) Practice I; Practice II.

#### ***The subject C4***

General economics I; General economics II; Professional communication; General elements of law; Accounting; Finances and credits; General management; Business law; Financial management (optional); Human resources management; Basics of assisted design; Negotiation techniques; Financial and economic analysis; Economic and commercial contracts (optional); The basics of project management; Practice for the elaboration of the dissertation paper (optional).

#### ***The subject C5***

Numerical methods for engineers; Technological methods and procedures; Electric and electronic measurements I; Electric devices; Electric technologies; Electric and electronic measurements II (optional); Transducers and sensors (optional); Static converters (optional); Electromagnetic converters (optional); Electro technic materials; Electric equipment; Inventions and industrial property (facultative); Reliability, Basics of assisted design; Electric action-generating systems; Systems with microprocessors; Electrical installations; The design of industrial electrical systems; Electro-thermal industry; Advanced production systems; The engineering of quality (optional); Energy sources (optional); Industrial energetics (optional); Microwave technologies (optional); The use of

electric energy (optional); Practice for the elaboration of the dissertation paper (optional).

### **The subject C6**

General management; Electric technologies; General elements of law; Accounting; Finances and credits; Business law; Quality management; International economic relations (optional); Human resources management, Reliability; Basics of assisted design; Negotiation techniques; Electric action-generating systems; Strategic marketing; Economic and financial analysis; The design of industrial electric systems; Advanced production systems; Organizational behavior; Economic and commercial contracts (optional); The management of product development; The basics of project management; The management of innovation and technology (optional); Multimedia and Internet techniques (optional); Professional communication.

### **The subject CT1**

General elements of law; Work law; Practice I; General management; Business law; Practice II; Quality management; International economic relations (optional); Human resources management; Basics of assisted design; Negotiation techniques; Economic and commercial contracts (optional); Economic legislation (optional); Quality engineering (optional); Quality engineering (facultative); Basics of project management; Professional communication; Foreign language (I, II, III, IV, V, VI); Sports (I, II, III, IV, V, VI).

### **The subject CT2**

Basics of project management; Human resources management; Foreign language (I, II, III, IV, V, VI); Sports (I, II, III, IV, V, VI); Practice for the elaboration of the dissertation thesis (optional).

### **The subject CT3**

History of science and technology (optional); Foreign language (I, II, III, IV, V, VI); Sociology (facultative); Multimedia and Internet techniques (optional); Professional communication.

### **Minimum performance standards for the evaluation of competences**

C1: Solving and explaining problems of average complexity, associated to the fundamental disciplines, specific to engineering sciences.

C2: Elaborating a professional project specific to the domain of Engineering and Management, using software systems and specific data bases.

C3: Design of economic-financial processes at the level of the business, for a given situation.

C4: Designing economic-financial processes at the level of the business, for a given situation.

C5: Designing economic-financial processes at the level of the business, for a given situation.

C6: Elaborating projects that follow the management of the enterprise from the electric, electronic and energetic domain.

CT1: The responsible achievement, in conditions of qualified assistance, of projects for the solving of problems specific to the domain, with the correct evaluation of the working volume, the available resources, the time necessary for completion and the associated risks, while observing the ethical professional norms and security and health in the field.

CT2: Completing a work/project as leader in a multidisciplinary team and the responsible distribution of specific tasks to the subordinates, while adopting a positive attitude of respect towards the team members.

CT3: The elaboration and support, in Romanian and in a foreign language, of a personal plan for professional development, using different sources and information tools.

## **5. Conclusion**

Given the current context of the Romanian economy structure, it is necessary to develop a specialization in engineering that might train specialists with multidisciplinary capabilities, able to solve the complex and continuous problems emerging on the labor market.

A specialization facilitating the acquisition of such capabilities is economic engineering, in general, and in the case presented above, the economic engineering in the electric, electronic and energetic domain, which belongs to the general field of engineering studies and also to the field of management and engineering.

Economic engineering is an outcome of innovating engineering in its structure within university bachelor degree programs in the field. A single supervisory system at the level of the European Union can ensure that all credit institutions are subject to prudential supervision and convergent supervisory practices. A supra-national supervisor is much better placed to assess the risks posed by cross-border activities, thus enhancing financial stability and confidence in the existing and the emerging euro area.

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