Engineering Graduation: Why Introduce Sustainability

Cynthia Maria de Andrade Lima*

*Departamento de Engenharia Civil, Universidade de Pernambuco, Recife, Brazil.
E-mail: cynthiaandradelima@gmail.com

Francisco José Costa Araújo*

*Departamento de Engenharia Elétrica, Universidade de Pernambuco, Recife, Brazil.
E-mail: francisco.araujo51@gmail.com

Karin Vanessa Cecília Panadés*

*Departamento de Engenharia Civil, Universidade de Pernambuco, Recife, Brazil.
E-mail: vkpanades@gmail.com

Abstract

This article exposes the importance of training Engineers who, since graduation, have in depth knowledge in both practical and theoretical areas of social, environmental and economic issues, including sustainability in its entirety. Through a bibliographical review of the existing materials in this context and the results obtained through researches, it was possible to confirm the theories addressed throughout the text. The pertinence of this article comes from the need to control the progress of the destruction of the environment that is directly influenced by the practice of the Engineering profession. The Engineer, because of his active participation in the changes in the environment in which he lives, has increasingly felt the need to adapt to the new world reality, which requires, both socially and economically, the introduction of sustainability in the practice of the profession. From this, we have succeeded in researches that demonstrated, through data and graphs, the growing requisition of the economic market for environmental certificates such as ISO 14001: 2015, used in Brazil, which had its emission intensified around 544% in the period of 2016 to 2017. However, with a survey conducted at the Escola Politécnica de Pernambuco, it was possible to note that only an average of 1.94 % of the Engineering curriculum is intended for sustainability.
education, thus confirming the importance of upgrading University programmes. In addition to this innovation in the facilities, it is necessary to live the principles of sustainability, as in the concept of “living laboratory”, in which Engineering undergraduate institutions become the means that allows and provides the insertion in the labor market, of a conscientious professional in relation to the sustainability pillars, including the social, environmental and economic spheres.

**Keywords:** Engineering, Environment, Environmental Certification, Living Laboratory, Sustainability, Undergraduate Education.

1. Introduction

Concern about environmental issues has become an increasing preponderant habit in the development and formation of society. Consequently, the formation of this ecological consciousness, in different sectors and layers of the population, ends up encompassing the education sector and, in particular, reflects in the Higher Education of one of the branches that most bring changes to the environment, the Engineering course.

The importance of education has been emphasized since the 1980s as necessary for the introduction of changes to sustainable development. In addition, at the United Nations Conference on Environment and Development (Rio 92) held in Brazil, a detailed plan, called Agenda 21, was proposed, with action strategies to seek sustainable development, based on interrelationship and interdependence between people, the environment and the economy. This document is of great importance because, besides being an educational process of orientation and reorientation that creates values and attitudes of respect for the environment and still the way to do it, it is the framework development and implementation of an important concept that continues to evolve: “Education for Sustainable Development”.

Taking into account the importance of this relationship between teaching and sustainability, Higher Education has a priority role as prepared professionals will have to deal with social, environmental and economic resources. In this way, it has become remarkable that its functions in the search for social transformations are to provide welfare improvements both for the people of the present generations and for the future lineages.

Admitting as a reference the Engineer's graduation, Engineering should be considered as one of the main disciplines for the transformation of society in search of sustainability, solving the usual questions and avoiding new problems. This area should still have professionals capable of making better decisions during the design and implementation of projects, thus becoming vital in the management of various aspects of socioeconomic and environmental issues. Thus, because the performance of Engineers cause possible impacts, often detrimental to the quality of life of living beings, it is imperative that their training be able to reflect on sustainable solutions to the professional problems they will encounter.

In addition to benefits to the environment, applying sustainability in Engineering becomes a new feature that is prestigious in the world market. For organizations present in a globalized business environment, it is a competitive advantage to obtain instructions and practices based on the principles of sustainable development.

This article seeks to answer the following question: What is the importance of the implementation of sustainability in Engineering graduation? For this, the research was based on the review of the literature on Engineering, sustainable development and the exhibition of advantages and challenges when joining the concept of sustainable development in the area of Engineering.
2. Literature Review

2.1. Contextualization of sustainability and education

The preservation of the environment began to become an agenda in world proportions, starting at the end of the 20th century, with the realization of important conventions in which the main ones can be organized in a “line of evolution”. In the 1970s, these meetings were carried out with the approach to the environment, where the Stockholm Conference was held in 1972. In the late 1980s, more specifically in 1987, sustainable development was first endorsed by the United Nations General Assembly where the concept of education for sustainable development was also explored. The 1990s will be remembered as the year in which the world’s concern was centered on sustainable development, for example, the United Nations Conference on Environment and Development (Rio-92). Then, in 2002, the World Summit on Sustainable Development in Johannesburg, South Africa, also enshrined the relevance of this proposal and the commitment of the nations present to implement it.

In addition, it is important to note that, according to Starkel, the international political commitment to Sustainable Development arose only with the Brundtland report in 1987, where its title has the idea of “Our Common Future” for conveying a consensus about the propositions for the future of humanity. Even so, it was during Rio 92 that Agenda 21 was presented, one of the most important documents on action tactics to correctly apply sustainable development. Because this agenda is an educational process of orientation and reorientation, it exposes, on a worldwide scale, the great relevance that education has in making society aware of its influence in the environment, specifically in its chapter 36, entitled “Promotion of Teaching, Awareness and Training”.

In 2002, in the city of Johannesburg in Africa, the World Summit on Sustainable Development took place, which became known as Rio +10. In this event, emphasis was placed on the importance of commitment to the environment and established the application of the three pillars of sustainable development: economy, social and environment. The statement from that meeting recommended to the United Nations General Assembly the Decade of Education for Sustainable Development (DESD), a learning process arising from the need for support to promote Sustainable Development. As Calder (2005) ponders, this was the right time to dedicate a decade to education for sustainable development. For more than a decade, a number of Universities, non-governmental institutions, and government agencies around the world have made significant efforts to mainstream sustainable development into academic programming. This implementation in education also covers the Engineering degree, where education about concepts, techniques and advantages of the application of sustainability in professional performance brings results that go beyond environmental preservation, as it also causes a significant differential for companies. After all, the incorporation of sustainable models of action starts to be seen as a differential capable of generating competitive advantages. Through this new model, education emerges and it becomes possible to define it as a learning process that has varied functions such as helping people to: think critically, develop a feeling of becoming better and learn to live together, making it a key mechanism for achieving sustainability.

2.2. The graduation in Engineering and the teaching in sustainability

Engineering emerges as one of the leading environment-modifying professions. Initially, this area was only concerned with meeting the basic needs of the human being, however, with the advancement of technology and greater legislative rigor, the need arose for an
Engineering that was increasingly concerned with the environment in which it operates.

In the Declaration of Talloires, carried out in 1990 in France, new objectives were brought to Higher Education. These new purposes consist in the greater integration between the well-being of society and the University itself, bringing out also the need for sustainability. The living laboratory explores this issue by making the institution a dynamic and spontaneous laboratory, using students’ experience as an experiment to improve society as a whole. This living laboratory concept is a way for scientific research to become a source of innovation and break down barriers between school and society. This need to break the paradigms of a stagnating University is extremely necessary even for the academic environment to reflect on what they teach.

Based on these principles, the Barcelona Declaration, which took place in Spain in 2006, then added the need to base the Campus on a sustainable basis with the need for a new profile in the training of Engineers, focused on social and ethical aspects. The Engineer of the future, besides needing to know deeply about technology and to understand contents, methods, theories or other aspects of technological knowledge, also needs an educational process oriented towards sustainability. To remain only in the integration of several themes would be to maintain the current reality by not turning technological knowledge into a perspective of social change. The processes that can save energy and resources, reduce pollution, increase productivity with equitable distribution of income and avoid capital wastage, go through education and technological innovation, guided by environmental conservation.

Therefore, the graduation of an Engineer, in the present day, besides providing the technical knowledge of the profession, should offer a humanized education, dealing with social and environmental issues as essential for the curriculum of these future professionals.

2.3. Pedagogical perspective in teaching sustainability

Environmental education, one of the pillars of sustainable development, contributes to the fundamental understanding of the relationship and interaction of humanity with the whole environment and fosters a public environmental ethics regarding ecological balance and quality of life, awakening in individuals and social groups organized the desire to participate in the construction of their citizenship. However, according to Danna, many professionals who finish their Engineering courses are poorly trained, mainly due to the fact that undergraduate students present practical, uncreative aspects with specific deficiencies in managerial, social and environmental knowledge. These factors directly affect the degree of development of the country.

It is necessary, then, not only to stimulate the student protagonism in this area, but also to provide theoretical and practical guidelines from environmental chairs. These attitudes serve to enrich the range of possibilities in relation to the decision-making that an Engineer must obtain in his/her daily life; thus choosing to preserve ethics, the environment and safety.

During the five years of Engineering graduation, the institution in question must have been able to provide the student with disciplines that have the following objectives: To embrace contemporary issues and their responsibility as a professional and citizen future; To inform the carrying capacity of ecosystems, as limiting in providing services; Analyze the history of the impact of human activities on the planet and possible means of mitigating it; Educate about new business opportunities, from legal milestones and consumer demand for socially responsible and environmentally balanced products and services; Clarify the laws and regulations governing Engineering and its duties to society and the environment; Establish the connections of the Triple Bottom Line (TBL) (environmental, economic and social) and
other dimensions of Sustainable Development that influence the discipline (culture, ethics, work safety, etc.); Formulate and use processes, products and components considering life cycle analysis, using as constraints, the dimensions of Sustainable Development. Among other objectives that can be adopted for the improvement of the Engineer in the sustainable reality, Environmental disciplines can no longer be an elective factor, but must be mandatory, since graduation has a total influence on the performance of the future Engineer towards society.

2.4. Advantages and challenges of applying sustainability in Engineering degree

The implementation of a more sustainable model in Engineering can bring not only advantages, but also some difficulties for the company that applied it. This adherence to more sustainable models requires a non-immediate attitude, but rather a short, medium and long-term planning vision. In this context, for Vasconcelos and Filho, within the company’s activities, it is necessary that the agency has concerns both with the environmental impact and with social responsibility towards its employees, external consumers, and suppliers. It is known that sustainability is necessary, but because it is a relatively new theme and requires a new paradigm of skills and abilities to make it viable, it results in a phase in which companies and academia are in learning. With this, it is noticed that there is a great professional relevance in the act of the University to innovate in its teaching with the implantation of the sustainable development.

In the Engineering area, corporations are among the ones that receive the most advantages in using this new sustainable knowledge, since, following the imposed norms, besides bringing benefits to the environment by reducing the impact generated, a business differential is obtained by being environmental certifications and seals. In an increasingly competitive world, companies come comparative advantages in acquiring certifications that attest to their good business practice. The pressure for socially correct products and services causes companies to adopt internal reformulation processes to comply with the standards imposed by the certification bodies.

Among some of the most coveted sustainable seals or certifications currently stand out are the ISO 14000, the Dow Jones Sustainability Index and, acting in specific areas of Engineering, there is the Leadership in Energy and Environmental Design (LEED), Procel Seal and the certificate provided by the Forest Stewardship Council (FSC). The ISO 14000 series of standards that constitute a set of standards for the implementation of an Environmental Management System (EMS), formulated by the International Organization for Standardization (ISO), is applicable to any type of organization that aims at achieving environmental performance correct and has to seek certification from a competent external organization. In addition, if the body undertakes to comply with the rules infringed by national legislation, the company, in addition to having to train its employees to follow all such impositions, should identify and seek solutions to all likely problems it may cause to the environment. It is possible to relate the main motivations for the implementation of ISO 14000 with the benefits that certification provides to consumers with higher satisfaction, standardized environmental management procedures, reduction of waste and reduction of resources used in the process (cost saving) and development of clean production procedures. As for the difficulties in its implementation, the high dependence of the employees' commitment and, consequently, the way in which the communication failures and the distortions in the power structures were motivated. Even after obtaining the certifications, they have validity and, for the maintenance and recertification of ISO, new audits are necessary. Because these ad-
justments and audits are accurate, the formation of several bureaucratic and/or economic difficulties on the part of the investment for the company occurs.

Internationally, with a purpose similar to that of other measures, the Dow Jones Sustainability Index was created in 1897 by Charles Dow, which lists companies that adhere to social and environmental causes. This index identifies the results of the practices employed by companies that have shares in the stock exchange, and classifies whether the techniques are sustainable or not. This act is intended to inform buyers if they are acquiring shares of companies with environmental and social responsibility and what are the advantages of acquiring them. The Dow Jones Index is one of the most relevant global economic indices, including the term Sustainable Company in its publication as well as valuing the company’s actions, encouraging it to continue sustainable practices. This is a very important method of inducing firms to care about the environment and society, giving them greater value and credibility.

In one of the areas of Engineering, more specifically in Civil Engineering, one has the LEED system. According to Leite\textsuperscript{17}, this index is based on a voluntary compliance program and aims to evaluate the environmental performance of an enterprise, in which certification takes place at levels that quantify the degree of environmental protection obtained in the construction project. The advantages of acquiring this seal is that, in addition to having already gained space in the national market, it is the preferred of multinationals to maintain the certification system in all its subsidiaries. However, LEED is still poorly adapted to Brazil, and this means, for example, that energy sources (clean matrix) are heavily weighted, with little value for labor issues and waste management.

The Procel Seal of Energy Economy, or simply Selo Procel, according to Cardoso\textsuperscript{18}, aims to guide consumers and stimulate the manufacture and commercialization of more efficient products in the country, thus avoiding excessive consumption of energy and preserving environmental resources. In addition, by being able to take this seal to the products of his company, the Electrical Engineer can bring the relevant advantage of showing a greater reliability in the economy, resulting in the sale of more goods and generating greater profits.

In relation to the certification provided by the Forest Stewardship Council (FSC), it can be stated, according to Ataide\textsuperscript{19}, that it aims to disseminate good forest management according to principles and ecological safeguards with social benefits and economic viability. For a Forestry Engineer, in addition to the great relevance of this certificate to promote the preservation of the environment, also stand out the facts that the approved companies will be able to reach new markets or expand the old ones; certified products will be highly desired by an increasing number of consumers concerned about the environmental consequences of their purchases; will contribute to improvements in the local quality of life and will have a profitable increase with their products.

It is crucial to be aware of the challenges posed by the application of sustainable development, where even Larentis\textsuperscript{20} points out that it is not enough to achieve a competitive advantage but also to sustain it. This undoubtedly adds new nuances and complications to business scenarios. Even with advantages and challenges, it can be observed that every year the number of certifications increases in Brazil. With this, the country has been improving its placement every year in the Ranking of number of certificates issued in the world. As an example, according to GBC Brazil, the country remains in 2017 in the fourth place in the ranking of 162 countries with the highest number of projects registered and certified Leadership in Energy and Environmental Design.
3. Results

Through the website of the Polytechnic School of Pernambuco, in January 2018, the programs of the graduations of 7 (seven) Engineering offered by the institution were analyzed, being Civil, Computing, Electrical Electronic, Electrical Electrical, Electrical Telecommunications, Mechanics and Control and Automation. Based on this research, it was observed that in the Electrical Engineering Program only three courses were directly addressed to environmental themes, while in Civil Engineering, Electrical Engineering and Mechanical Engineering, two courses were found. With the smallest number of compulsory courses related to this sustainable subject, we find Computer Engineering, Electrical Telecommunications and Control and Automation, where it was analyzed that only one curricular component enters the total workload required.

Through a periodic analysis, Graph 1, is possible to identify the data sources of the curricular components in the total time load of the obligatory courses. In this case scenario, the Electro technical Engineering graduation presents a greater percentage value of 4.0%, and the Control and Automation Engineering only 0.8%. As the disciplines can contemplate the areas of environmental study and diluted in facilities, it is noted that there is still a lack of due emphasis and curricular strategies that sustainability requires for engineering graduation.

Another analysis was carried out in relation to the issuance of ISO 14001: 2004 ABNT certificates and ISO 14001: 2015, where, through data collection on the INMETRO website in May 2018, the Graph 2 was assembled, where can be noted the high growth of requests
and emissions that the ISO 14001 certificates are receiving from 2008 to 2017. In 2015, there was the highest registered emission of ISO 14001: 2004 with 665 certificates. After this year, it becomes clear that ISO 14001: 2015 has begun to become a more up-to-date and long-awaited certificate than 2004.

In 2018 alone, this search for the ISO 14001: 2015 certificate achieved a great growth, where it is expected to surpass its total recorded for the year 2017, as shown in the Graph 3.
4. Conclusions

In the course of this article it was observed that the role of the Engineer in society is indispensable, but that the profession can bring both benefits and harm to the environment in which it operates. Sustainability emerges as a necessary factor for the maintenance and modernization of modern Engineers as organizations have become aware that economic growth, without a concern for the replacement of natural resources, has not been favorable to either party.

The population also, in a comprehensive way, has charged companies and opted for products that are manufactured in a way to minimize the degradation of the environment and, if possible, that the products have the raw material replenished in nature, as is the case of companies that do the replanting after the harvest. The formal education system, especially Colleges, University Centers and Universities, have also been concerned with training more environmentally conscious managers, teaching them to make economic growth in order to reduce the imbalance that organizations may cause in nature, but we are still far from ideal. With this sustainable deployment in the Engineer’s graduation, it was shown that the consequences directly influenced his professional performance, most expressed through Dow Jones indices, environmental seals and strict standards. These factors have also become a prerequisite for clients and for the economic market in general, which opts for companies that invest in sustainable models of action.

From this thought, there must be undergraduate renewals of these professionals, including compulsory theoretical and practical chairs, as well as case studies and scientific initiations that focus on sustainability, ethics, and the economic factor. Having this concern with the training of academics, the institution will train not only Engineers, but professionals capable of generating creative, profitable and environmentally correct solutions that will favor the economic market and future generations. However, there is a need for ongoing monitoring and evaluation of education so that curricula can be reviewed and adapted. In addition, it is critical to question what is missing, what is unnecessary, what to teach and how to do it.

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Therefore, it can be concluded from the analysis made in the program of the Engineering courses of the Escola Politécnica de Pernambuco and in the issuance of ISO 14000 certificates by companies, that the graduation should suit, increasing the offerings of courses related to the sustainability, the growing demand of society for sustainable actions in the Engineering field, resulting in the exercise of the profession focused on environmental, social and economic concerns.

Reference


