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ENGINEERING ETHICS – MAIN PRINCIPLES

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Purpose: The aim of the paper is to analyze the main principles of the usage of the engineering ethic in the enterprise.
Design/methodology/approach: Critical literature analysis. Analysis of international literature from main databases and polish literature and legal acts connecting with researched topic.
Findings: Engineering students should learn the concepts of engineering ethics in much the same way as they learn technical topics. As they build awareness of ethical issues related to engineering and learn about the tools available to deal with ethical dilemmas, such as codes of ethics, they should be able to extrapolate this knowledge and anticipate some of the problems that may arise. We believe that every engineer should be familiar with the basic concepts of engineering ethics in order to make proper use of ethical codes in their country and their organisation. An ethical approach to engineering can achieve better working conditions and better outcomes for all people and stakeholders of the organisation
Originality/value: Detailed analysis of all subjects related to the problems connected with main principles of engineering ethic.

Keywords: ethic, ethic codex, human resource management, Industry 4.0.

Category of the paper: literature review.

1. Introduction

The word 'ethics' comes from the Greek word 'ethos' meaning 'character'. Ethics is a set of rules or principles that are generally considered to be the norm or right and wrong or right and wrong that are usually imposed by an outside group, society or profession or so (Engineering Ethic, 2018).

Engineering ethics is part of a broader concept called business ethics. The concept of business ethics includes the following areas (Robinson et al., 2007):

- The values that underpin business, including values relevant to particular professions in business, such as accountants or managers.
- Identify how values can be embodied in the organisation. This includes the development and implementation of appropriate codes of ethics.
- Specific policies identified in organisations in areas such as corporate governance or workplace relations.
- Broader corporate responsibility towards the local community and environment and global issues – implementation of the concept of corporate social responsibility.

Especially in the times of Industry 4.0 when there is a big importance of the information and digitalization (Kwiotkowska et al., 2021; Stawiarska et al., 2020; 2021) we should put attention on the role of the engineering ethic within the enterprise (Drozd, and Wolniak, 2021; Gajdzik, and Wolniak, 2021). The good managed organization in the Industry 4.0 conditions should implement the ethic code to their business practice.

The aim of the paper is to analyze the main principles of the usage of the engineering ethic in the enterprise.

2. Ethical actions

In determining whether or not a given action is ethical, we should focus on five basic skills: moral reasonableness, respect for the person, tolerance of diversity, moral hope and integrity. These are characterized in Table 1.

Table 1.
Basic skills in identifying actions as ethical

Skill	**Charavteristic**
Moral rationality	The ability and willingness to act morally.
Respect for the person	Treating other people with care.
Tolerance for diversity	There needs to be a broader view of the ethnic and religious differences that exist between people. Each person is different from the other when they are compared on the basis of moral reasoning. Acceptance of these differences is really important.
Moral hope	Moral conflicts can be resolved through better communication and rational dialogue, based on facts, open, which is accepted and appreciated by both sides.
Integrity	Moral integrity must be maintained. Being honest and having strong moral principles helps in effective problem solving. You should also consider the professional life and personal beliefs of others when solving a problem.

Source: author's own analysis on the basis: (Harris et al., 2006).

The importance of engineering ethics is due to a number of factors affecting the field. These are described in Table 2.

Table 2.
Factors influencing business ethics

Factor	Characteristic
Globalisation	Globalisation has contributed to the growth of international business in such a way that it is estimated that over half of the world's largest organisations are corporations. The fact that they must work closely with various governments around the world has led to an increased sense of responsibility for their actions.
Information and communication technologies	This has led to an increase in global transparency as a result of rapid access to information from many different sources. As a result, it has become increasingly difficult for organisations to hide what may be the more controversial aspects of their activities.
Fiscal pressure	Increasing fiscal pressures have forced companies to withdraw from previous philanthropic endeavours. At the same time, this has led to greater discussion about the roles of government and business and how business can contribute to society.
The growing importance of intangible assets	This is linked to the recognition that in the new economic environment there is a system of values shared by a significant proportion of society on which the success of the organisation depends. It is also partly linked to growing public awareness of key issues such as sustainability.

Source: author's own analysis on the basis: (Harris et al., 2006).

The word ethics has many meanings, as does engineering ethics. According to the literature, we can define engineering ethics as the study of moral problems and decisions facing individuals and organisations involved in engineering; and the study of related questions about the moral conduct, character, policies and relationships of people and organisations involved in technological activities (Martin, 2009). Morality includes the beliefs and practices about right and wrong by which we guide our behaviour. According to another definition, engineering ethics consists of the duties and rights that should be observed by those involved in engineering activities, as well as the desirable ideals and personal commitments in engineering (Gębczyńska, and Wolniak, 2018; Grabowska et al., 2021; 2020; 2019). Engineering ethics is the study of decisions, policies and values that are morally desirable in engineering practice and research (Martin, 2009). Engineering ethics, like all detailed ethics, makes sense insofar as it can be used in everyday activities by those in professions whose specificity sets such a framework for ethical reflection (Jaśtal, 20018).

It is believed that the professional morality of an engineer depends on his individual morality – without the latter the former cannot be achieved. In a situation where morality is not in line with the content of the ethical codes, there will be no goods in the society which postulate the content of these duties (Pyka, 2010).

In order to perform his tasks well, an engineer, in addition to in-depth professional knowledge, must have some understanding of moral issues. Due to the specificity of professional situations, this understanding must sometimes go beyond the usual canon of moral decency. Codes of ethics of professional organisations can assist in discerning the moral aspects of typical professional situations. Such codes of ethics should not be considered as a set of precepts and prohibitions, but only as a set of guidelines, helping (especially young and inexperienced professionals) to avoid typical temptations and pitfalls arising in professional practice, related for example to conflicts of interest, to frictions arising from the relationship between different social positions (e.g. boss-employee, designer-contractor, professional-

client) or to the definition of substantive, legal and moral responsibilities of individuals and legal entities (Jaśtal, 2018).

3. Codes of ethics

Due to the fact that at the level of the description of the situation, the codes of ethics only indicate minimum moral standards of behaviour, their message is primarily expressed not in commands and prohibitions, but in the presentation of desirable models of personality. Such models include not only purely professional competences, but also various criteria for defining a person as a trustworthy professional. Such criteria may include, for example (Wajszczyk, 2013):

- the ability to take into account in his/her activity the general social objectives,
- ability to shape relationships within a group,
- awareness of the limits of one's competence and the scope of professional autonomy,
- awareness of the inevitable risks involved in their undertakings.

The concepts of ethics and morality are not unambiguous, nor is the relationship between them. One of the main meanings of these terms is related to the distinction between normative and descriptive ethics. Ethics here belongs to the realm of knowledge and theory – morality, as actual human conduct, belongs to the empirical realm.

The codes of professional ethics of the engineering profession are dominated by duties which may be regarded as the canon of moral conduct in the engineering profession (Wajszczyk, 2013):

- the paramount importance attached to the safety, health and welfare of society,
- providing services only within the scope of one's own competence,
- making public statements only in an objective and truthful manner,
- acting for an employer or client as a trustworthy representative or agent,
- avoiding fraudulent acts,
- acting with dignity, responsibility, ethics and in accordance with the law so as to enhance the honour, reputation and usefulness of the engineering profession.

In the engineering profession, advanced knowledge in a given engineering specialty is needed in addition to an efficient professional court. Its scope and level is in the focus of technical universities, while the importance of professional judgment education remains little clearly perceived. This is because the skills that are included in the concept of sound professional judgement are not amenable to scientific theory – they need to be considered on a case-by-case basis and it is difficult to make accurate generalisations. Similarly, the role of good moral judgement of a situation is not sufficiently brought out and emphasised in textbooks

on engineering ethics and business ethics. Professional experience, like life experience, cannot be effectively conveyed in the form of a verbal message, much less a lecture of some general theory. Therefore, the following normative recommendations are formulated in relation to engineering professional judgment (Pyka, 2010):

- The engineer should possess and develop technical knowledge.
- The engineer should strive to educate and continuously develop the capacity of his/her own professional judgment. He should be faithful to this judgment in all decisions and actions of his professional practice.

When considering problems in the field of engineering ethics, it is worth mentioning a concept called whisteblowing. This activity consists in disclosing irregularities, illegal, dishonest or forbidden actions which occur in the workplace. A necessary criterion for this system to work effectively is that the whistleblower acts in good faith, i.e., based on facts and other objective motivations, as opposed to personal considerations. A whistleblower is a person who reports or discloses irregularities or ethical doubts concerning behaviour, actions or phenomena occurring in the workplace (Sygnalista, 2017).

A distinction is made between internal and external whistleblowing. If the information about the wrongdoing in the company has been communicated to the management or the relevant organisational unit, it is called internal whistleblowing. If, on the other hand, the information has been communicated to the public or to an audit institution, then there is external whistleblowing (Jonek-Kowalska, and Wolniak, 2021). External whistleblowing can have disastrous consequences for an organisation in the form of loss of orders, contracts, positive image, customers, a series of burdensome inspections, sometimes leading the organisation to bankruptcy. For this reason, it is in the interest of the organisation that information about irregularities does not get out (Lewicka-Strzałecka, 2014).

Whistleblowing has many benefits for both organisations and their employees who use this form of whistleblowing. Among the most important are (Bielińska-Dusza, and Żak, 2018):

- minimising the risk of reputational or financial damage through the early detection and management of incidents of fraud or irregularity;
- increasing the chance of detecting undesirable activities, more effectively preventing such events in the future;
- gaining knowledge about fraud in order to reduce, eliminate and counteract it;
- Supporting the creation of an ethical working environment, increasing employee engagement;
- reducing the risk of litigation and, if disputes do arise, increasing the chances of a positive outcome;
- decrease the number of irregularities and abuses thanks to a clear and safe system of reporting them;

- strengthening the image of an honest and ethical company among internal and external stakeholders (an effective element of employer branding);
- building the image of a transparent and professionally managed company – through disapproval of abuses and people who commit them, and through documentation of the company's activities concerning counteraction and combating irregularities;
- counteracting the tightening of legal regulations limiting the freedom of economic activity, which can be caused by tolerating abuses by companies;
- in the long run, reducing revenue losses, thus achieving both economic and image gains.

In American textbooks on professional engineering ethics, one can see the intention to develop the ability of readers to solve ethical dilemmas independently or in groups. Teaching engineering ethics can lead to the following goals (Wajszcyk, 2013):

- To make students aware of the existence of a structured set of professional norms and duties expected of an engineer in the course of practicing his profession, the student must in this case be able to recognize and distinguish between the different types of duties, define their content and explain with examples what actions and attitudes are desirable and what are not. The training effect will be the acquisition of specific knowledge.
- Acquisition of skills of desirable behaviour in professional situations specified by the code of conduct, giving rise to conflicts of norms and ethical dilemmas or various professional temptations (fraud, corruption) and providing a way to solve them. Obtaining this effect means gaining appropriate skills and requires the application of various materials and didactic techniques in order to achieve the desired level and persistence of learning outcomes.
- The range of attitudes such as: demonstrating awareness of the social role of a technical university graduate, the need to formulate and communicate information and opinions to the society concerning the achievements of technology and other aspects of engineering activity.

A well written professional code of ethics related to the engineering profession should include the following issues (Engineering Ethics, 2018):

- Responsibility to the profession.
- Responsibility to oneself.
- Responsibility to the employer with whom the member is an employee.
- Responsibility to the client.
- Responsibility to other individual members of the group or profession.
- Responsibility towards the community.
- Responsibility towards the environment.
- Accountability to other groups or professions.

- In addition, the code should address issues relating to responsibility for confidentiality – and include whistleblowing.
- The code should also include statements on how to determine whether members have broken the institution's ethical rules.

An example of a code of conduct for the engineering profession is the document produced by the National Society of Professional Engineers in the USA. The NSPE is the only engineering society that represents engineers of all disciplines in the USA. Its original code of ethics was approved in 1946. In this chapter we have used the latest version from 2019. The current code is quite comprehensive and has many detailed rules of conduct as well as professional responsibilities. Public safety, technical competence, accurate data, avoidance of conflicts of interest and other improprieties, professional behaviour based on integrity and professional development are important and are emphasised in the NSPE code of ethics (Baura, 2003).

The example of a code of ethical conduct, shown below, comes from England – it is a document prepared by the Engineering Council. It states that institutions should ensure that they have appropriate disciplinary processes in place that follow the council's guidelines. The following 16 responsibilities for engineers are highlighted (Guidance, 2016):

- Have the right skills, act with care and diligence and with due regard to professional standards.
- Prevent avoidable risks to health or safety.
- Prevent avoidable risks to both physical and cyber security.
- Operate in a sustainable manner and prevent avoidable negative environmental and social impacts.
- Maintain and improve one's competence, undertake only professional tasks for which one is competent, and disclose appropriate limitations to such competence.
- Accept responsibility for the work performed under their supervision.
- Treat all persons fairly and with respect.
- Encourage others to develop their knowledge and competence.
- Avoid, where possible, actual or perceived conflicts of interest and inform stakeholders when such conflicts arise.
- Comply with the obligation of confidentiality towards relevant parties.
- Reject bribery and all forms of corrupt behaviour and make positive efforts to ensure that others do the same.
- Report concerns about danger, risk, misconduct or wrongdoing that affects others ('blow the whistle') and support a colleague or other person to whom you have a duty of care who raises such concerns in good faith.
- Assess and manage risks and communicate them appropriately.
- Assess liability and have professional indemnity insurance where necessary.

- Notify the institution of a criminal conviction, bankruptcy or disqualification as a company director.
- Notify the institution of any significant breach of the institution's code of conduct by another member.

An example of a Polish code containing issues relating to engineering ethics is the code of professional conduct for members of the Polish Chamber of Civil Engineers. This code specifies two main objectives of engineering activity (Kodeks, 2018):

- The purpose of engineering activity is to continuously improve the living conditions of people by shaping the natural environment respecting its value for human needs, health, social and individual development.
- Engineering activity as a service to the society, is a carrier of its civilization development and co-creates its culture. This activity also satisfies the current needs of society, taking into account the experience of the past, the anticipated directions of development and their consequences.

Issues concerning the interaction between the engineer and society have found their place in the Code (Kodeks, 2018):

- In his activities, the engineer shall be guided by the public good and the principles of professional and personal integrity.
- The engineer shall be mindful of the consequences of his/her activity reckoning with the threats to the safety, welfare, health and life of people.
- Engineering activity is an art and the engineering profession is a profession of public trust. Care for the increase of the authority of the profession should characterise the engineer's work and his public appearances.
- An engineer should express professional opinion only if it is based on appropriate knowledge.
- An engineer shall not allow corrupt actions, both in his own conduct and tolerate them in others.
- The engineer shall take part in social activities and use his knowledge and experience for the betterment of life.

It also draws attention to issues of the engineer's attitude to the environment. The following paragraphs (Kodeks, 2018) address these issues:

- The engineer's awareness of the impact of changes and limitations in environmental conditions should accompany his decision-making, especially in the sphere of investment or related to the operation of the infrastructure entrusted to his care.
- The engineer should have a full understanding of the impact of his work on the environment.

- The engineer should be aware of the interdependence of various ecosystems. He should prevent the introduction of changes to the environment which would cause its permanent degradation. Damage caused to the environment as a result of investment or operation activities should be removed or reduced to a minimum upon completion of the work.
- As far as possible, the engineer should use renewable and recycled materials in his works.

Another example of an ethical code in the engineering profession is the code developed by PZIITB – Polish Association of Construction Engineers and Technicians. The code of ethics of this society consists of the following points (Kodeks, 2018):

- Never to disappoint the public trust that society has placed in my profession.
- Strive for the civilisational development of the country and society and contribute to its culture.
- Constantly improve my professional qualifications.
- Be guided by the public good and the principles of professional and personal ethics.
- Observe the rules of building and construction process safety.
- Serve the good of the association, its ideas and goals.

According to research conducted by the Polish Chamber of Bidding Engineers (PZIIB), the most frequent violations of ethical principles concern such issues as (Kodeks, 2018):

- unjustified questioning of the skills and competences of other chamber members;
- using unfair competition;
- incomplete or simplified execution of commissioned work, often caused by undercutting the price;
- issuing opinions and technical expertise tailored to the client's expectations, disregarding the principles of knowledge and the art of building;
- misleading principals with regard to the authorisations, knowledge and experience held;
- undertaking the performance of tasks without the required authorisation.

Another example of the Polish Code of Engineering Ethics is the FEANI Code of Ethics developed by the Association of Polish Mechanical Engineers and Technicians (SIMP). According to this code, an engineer bears the following obligations in terms of professional ethics (Kodeks etyczny, 2018):

- An engineer undertakes only those tasks that are within the scope of his expertise. When a task exceeds the limits of his professional competence, he should seek the cooperation of appropriate experts.
- The engineer is responsible for the organisation and execution of his tasks.
- He must obtain a clear specification of the services expected of him.
- In carrying out his tasks, he takes all necessary measures to overcome the difficulties encountered, while ensuring the safety of people and property.

- He/she shall receive a fixed remuneration, commensurate with his/her services and responsibilities.
- He shall endeavour to ensure that the remuneration received by all persons with whom he works is commensurate with the work performed and the degree of responsibility incurred.
- An engineer strives for a high level of technical achievement, including the technologies used, which will contribute to maintaining a healthy and pleasant living environment.

According to the rules of professional ethics, a member of the Chamber in disciplinary proceedings may be punished for breach of the code of ethics with: a warning, a reprimand, suspension of membership in the Chamber for two years or, in extreme cases, removal from the membership list (Sułkowski, and Wolniak, 2016; 2015; 2018; Wolniak, and Skotnicka-Zasadzień, 2014; Wolniak, 2011; 2013; 2014; 2016; 2017; 2019; 2020). In practice, the consequence of suspension or expulsion is a ban on performing independent technical functions in the construction industry. It should be added here that, in the case of expulsion from the list of the chamber members, re-admission can be applied for after a lapse of 10 years. In effect, such a long break means elimination from our professional group (Kodeks, 2018).

In Poland, professional organisations and associations provide training, lectures and readings on professional ethics. However, these initiatives are uncoordinated and the resulting works are scattered and irregular (Wolniak, and Sułkowski, 2015; 2016; Wolniak et al., 2019; Wolniak, and Hąbek, 2015; 2016; Wolniak, and Jonek-Kowalska, 2021; 2022; Wolniak et al., 2020; Wolniak, and Skotnicka, 2011; Wolniak, and Skotnicka-Zasadzień, 2010; 2018; Hąbek and Wolniak, 2013; 2016; Hys, and Wolniak, 2018; Ponomarenko et al., 2016; Wolniak, and Grebski, 2018). There is currently a lack of coordinated cross-university and nationwide activities supporting professional ethics and aimed at universities and engineering associations (Wajszczyk, 2013).

Based on the information described in this chapter, one can try to identify why it is important to study engineering ethics. Why this concept is important for an engineer. We can distinguish the following reasons why this kind of professional ethics should be analysed and studied (Kodeks etyczny, 2018):

- Engineering by its nature is a profession of managing the unknown, and this involves higher risks that reflect on the end users (society).
- To sensitise engineers to important ethical issues before they have to face them and to create an appropriate awareness that can influence the earliest stages of engineering endeavours.
- To develop 'moral autonomy' and enable engineers to self-regulate and protect the safety and well-being of society, as well as the profession, regardless of the environment or place of operation.

- To train engineers to analyse complex problems and solve them in the most ethical way, without compromising their personal ethics or professional obligations.
- Engineering ethics is not about doing the right thing when the ethical choice is obvious. It is about finding the basis in a complex ethical dilemma that achieves the most benefit and least harm for all parties without compromising public safety, resources, clients or the profession.

4. Conclusion

Engineering students should learn the concepts of engineering ethics in much the same way as they learn technical topics. As they build awareness of ethical issues related to engineering and learn about the tools available to deal with ethical dilemmas, such as codes of ethics, they should be able to extrapolate this knowledge and anticipate some of the problems that may arise (Barakat, 2011).

We believe that every engineer should be familiar with the basic concepts of engineering ethics in order to make proper use of ethical codes in their country and their organisation. An ethical approach to engineering can achieve better working conditions and better outcomes for all people and stakeholders of the organisation.

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