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Ethical Aspects of Science and Technological Innovations

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Abstract: The progress of civilization depends on both science and ethics, on two different ideas. Unlike ethics, which deals with moral principles and ideals that guide human behavior, science is based on logical argumentation, empirical data, and methodical testing. However, as science develops, it often raises ethical questions that must be addressed. As a result, science and ethics are intertwined and both are essential for the moral and long-term advancement of science. This research examines the results of two interconnected processes: the quick development of science and technology and its moral ramifications, or the harm it does to people's lives all around the world. The writers highlight the need for a qualitative shift in attitudes toward nature and society as a whole in order to address environmental challenges and remove the threat of a global ecological disaster by analyzing the substance and impact of these processes.

Keywords: Science, technological development, ethics, sustainable development.

Introduction

Similar to other sectors of contemporary life in growth, ethics are prevalent in science and technology. It is essentially an informal (normative) science that examines social norms of human conduct. In addition, because it examines what is good or wrong, it is regarded as a subfield of philosophy that deals with the nature of moral judgment. On the other hand, ethics has a close relationship with morality, and although it has the same essence, it is different. On the other hand, ethics is a set of norms that come from within, they are personal norms, while morality represents those that come from outside, that is, from society. Science and technology are not exempt from ethics. Although it is true that both fields have contributed greatly to the benefit of society, it is true that many times they end up being unethical.

In the past, it was believed that the ethics of science only applied to those aspects of the scientific method, such as the justification of knowledge with empirical and logical evidence, the way in which scientists respond to new empirical data, and how they are willing to accept review and criticism of their scientific hypotheses. Apart from these operational guidelines, however, the ethics of science must also be assessed in terms of the methods it uses to conduct its research and the degree to which it participates in discussions and decisions regarding the application of its knowledge based on ethical standards.

However, environmental degradation is a constant byproduct of rapid economic growth and population expansion. The most difficult contributors to environmental health issues include industrialization, increased agriculture, and rising energy use. The advancement of the technical-technological foundation of human work was associated with both advantages and a certain risk of endangering and disrupting man's integrity at work and the ecological balance in the natural environment, which is the biological context of his life. Because industrial risk is a companion to industrial civilisation, it is often described as a civilization of peril. Globalization was made feasible by high-tech industries like computers and electronics, which were formerly seen as relatively clean due to their safer workplaces and less environmental effect. „However, the perception of the effects of these technologies today is negative. From the perspective of preserving the integrity of workers and preserving the ecological balance of the environment, work in these industries is also not safe" (Marković, 2002).

The topic of biotechnology is one of the main places where science and ethics meet. The development of genetic engineering and synthetic biology has the potential to greatly benefit society

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by improving the food supply and treating disease, but it also presents ethical questions. Is it moral to genetically modify human embryos, for example? Should artificial life forms be patentable? These are questions that require rigorous ethical investigation and reflection.

Animal research is another arena where moral and scientific issues coexist. Animal studies are often used to test new medical procedures, but they also raise concerns about the ethics and welfare of the animals involved. When conducting experiments, scientists must keep in mind the welfare of the animals used in the study and take precautions to prevent undue harm. The scientific community must strike a balance between the benefits of using animals in research and moral concerns for their welfare and respect for living creatures.

Science in the function of the development of society

Since the beginning of mankind, science and art have been considered intelligent creations, and the first systematic knowledge appeared in Greece around 600 BC. Even then, it was considered that every individual is homo moralis by essence, simply because he is homo sapiens. Modern science, above all psychiatry, psychology, anthropology, sociological sciences, cannot define homo sapiens completely and comprehensively. At that time, the medical profession of Ancient Greece was absolutely separated from religion and doctors were trained according to the most rigorous system. The ruling principle was that everyone has the right to medical help, and the doctor, in addition to medical knowledge, also had to strictly ethically apply his skills to the sick. The Medical Consilium was introduced in the Hippocratic School for the seriously ill. Hippocrates' students and collaborators collected 53 of his works and published them in 72 books under the name "Hippocrates Collection" and handed them over to the Library of Alexandria for safekeeping.

There are many periods of discovery in science that have been crucial in shaping modern science, and they can be categorized into three significant scientific revolutions that have taken place over the centuries. These are the Scientific Revolution, the Industrial Revolution, and the Digital Revolution. The Scientific Revolution of the 16th and 17th centuries was one of the most important periods of discovery in science. During this time, scientific inquiry began to shift from medieval ways of thinking to a more empirical approach. The Industrial Revolution of the 18th and 19th centuries was another critical period of discovery in science. During this time, there was significant progress in the fields of mechanics, chemistry, and electricity. Innovations such as the steam engine and the telegraph transformed society and allowed for unprecedented levels of productivity and communication (Ho, 2023). The Industrial Revolution also stimulated scientific inquiry, with researchers focusing on ways to improve manufacturing processes and develop new technologies that could further advance society. Finally, in the 20th and 21st centuries, we have seen the emergence of the Digital Revolution, which has opened up new possibilities in areas such as artificial intelligence, robotics, and medicine. Breakthroughs in computer technology have transformed the way we live, communicate, and conduct scientific research. Researchers today are exploring concepts such as virtual reality, quantum computing, and gene editing to unlock new horizons in science. The largest-selling newspaper in Europe, the German tabloid Bild, has told workers that it expects to make more editorial cuts as a result of "the opportunities of artificial intelligence" and has planned a €100 million cost-cutting initiative that would result in 200 layoffs. ChatGPT is an example of an AI tool that can produce very complex text from basic user prompts. It can produce anything from essays and job applications to poetry and works of fiction, although occasionally the results are incorrect or even made up (Henley, 2023).

The history of science is marked by numerous periods of discovery that have greatly transformed our understanding of the world. These periods, characterized by astonishing breakthroughs and scientific advancements, have laid the foundation for the modern scientific inquiry we rely on today. One such period of discovery occurred during the Scientific Revolution in the 16th and 17th centuries, where scientific giants like Galileo Galilei and Isaac Newton revolutionized our understanding of the natural world. Another significant period was the Atomic Age in the mid-20th century, characterized by groundbreaking discoveries in nuclear physics and the development of atomic weapons, along with the birth of quantum mechanics. These periods of discovery have shaped the course of human history and led to remarkable scientific and technological advancements. Today, "periods from discovery to their application are getting shorter" (Dobrov, 1969; Sarić, 2002). After a month, word of the British colonies' unilateral proclamation of independence in the New World (USA) reached Europe. The assassination of United States President Abraham Lincoln in April 1865 "travelled" to Europe for 12 days, making it the greatest and most significant news of the 19th century.The American president was killed in Dallas, Texas, in November 1963. At 1:00

p.m., he passed away. The news was first reported to 68% of Americans simultaneously, followed by 92% at 2 PM and 98.8% at 6 PM. Consequently, the entire nation learned pretty rapidly (Kapferer, 2016).

The advancement of science is seen everywhere in the world. More people than ever before are enrolled in universities thanks to advancements in society, science, living conditions, etc. Organized study is becoming more and more important for gaining new information, whereas accidental and haphazard discoveries are becoming less and less common. By integrating science in education, learners are exposed to new and innovative ideas that challenge their understanding of the world around them. They are equipped to think critically and analytically about problems and develop practical solutions. Science education also encourages curiosity, creativity, collaboration (Parker and Kingori, 2016), and communication. These skills are essential in both academic and professional settings and contribute to the overall development of learners. Furthermore, science education plays a significant role in preparing future generations for a world that is increasingly dependent on technology and scientific advancements. It helps students to understand and appreciate the impact of science on various aspects of society, including health, agriculture, environment, and energy. In order to create knowledgeable citizens who can make decisions that benefit their communities and the wider globe, a solid foundation in scientific education is essential. Overall, the growth of people, society, and the globe depends on science as an educational tool.

For the general development of the economy and society as a whole, encouraging innovation is crucial, as is raising awareness of its significance. Only by combining three markets—the market for ideas, the market for cash, and the market for talent—could Silicon Valley claim success (Dašić, 2023). Many innovative and business-minded individuals melded into the Valley and introduced fresh concepts. As a parallel to Silicon Valley, which was envisioned as a hub of global scientific thinking, the new Russian innovation center "Skolkovo" is the product of collaboration between the government, business, and scientific communities.

Science and technology have been and still are the cornerstones of human progress. Man has increased his power, material wealth, and skills over time by using discoveries and technology. Thus, the expansion of science and technology contributed directly to the expansion of the human race, as well as to improvements in living standards and overall quality of life. "The major aspect of development in the future should guarantee the greatest standards of living, assure the long-term advancement of human civilization, and also allow for the growth of human colonies outside the planet. Given these facts, it is clear that science and technology are an essential component of quality of life" (Milivojević, et al., 2012)

More efficient utilization of natural resources is now achievable thanks to the use of science, technique, and technology. Only in the last thirty years have targeted measures to stop environmental degradation been put into practice. Thanks to technical improvements, recycled materials may now be used to generate newspapers for much less money, while glass manufacturers may use up to 90% recycled resources. With 85% recycled material, Toyota and Honda produce vehicle parts. Garbage is no longer considered waste at these companies; instead, it serves as a resource for business and a driver of innovation.

However, in order to reach the knowledge that will lead to a better life on earth, we must take into account the ethical dimension. Dr. Franz Heimlich received the greatest scientific honor - the Nobel Prize - while working at the Hudson Institute, a private college in New York State. The real Hans Stein, who worked with Dr. Josef Mengele during the Holocaust and is regarded by many as being responsible for 400.000 Jewish fatalities, was identified after his persona became more well known. Stein helped Mengele, dubbed the "Angel of Death" or the "Butcher," conduct medical experiments on thousands of Jews that left the patients permanently paralyzed. „His medical advancements were therefore made feasible by information gathered from cruel tests performed on Holocaust victims" (Dej, 2008).

Nevertheless, the application of technological solutions (rapid development of industry, energy, transport, urbanization, and military technologies) has extremely negative effects on the environment and a sharp increase in risk to the human community, in addition to the extremely positive effects of science and technology on the human community and its quality of life. There are numerous and diverse ways that science and technology harm the environment and human existence. Lastly, the misuse or unethical utilization of scientific knowledge has resulted in harmful consequences. Science can be manipulated and used to deceive people or for unethical purposes. An example is the rise of fake news and misinformation, where scientific studies can be misinterpreted or misused to spread false information and ideologies. Additionally, advancements in biotechnology have raised ethical concerns regarding genetic engineering, cloning, and manipulating the human genome. The potential misuse of such knowledge could have severe consequences, both on an individual and societal level (Dašić, Kostadinović and Kostadinović, 2022).

"The global Internet and other new media, in such circumstances, bring new ethical challenges as well. It is a fact that technological breakthroughs also introduce new approaches to unethical behavior

and that one of the biggest concerns from that level is the ease with which personal information can be collected and shared over the Internet" (Bjelajac, Filipović and Stošić, 2022). The ethics of new media are inseparable from the state of moral communities in which these media operate; the "moral chaos" on the Internet has less to do with this technology, and more with the state of morality in the societies that use it (Bajić, 2020).

Baudrillard calls this new human environment postmodern reality. Reality is replaced by its signs, and the function of media images in the system of the death of reality is to leave reality without the opportunity to ever be produced again. "The surreal is now already protected from the imaginary, leaving only room for the orbital return of the model and the simulated creation of risk" (Bodrijar, 1991, 6-7): Baudrillard is aware of the role of the development of technology, and above all information technology, in the loss of man's contact with reality: "The image itself can no longer represent the real, because it is the real itself." He can no longer even dream of it, because it is his virtual reality. As if things swallowed their own mirror and became transparent to themselves..." (Bodrijar, 1998, 14). Instead of disappearing from themselves due to the illusion, according to Baudrillard, those pictures are compelled to be "printed on millions of screens on whose horizons not only reality, but the image itself, disappears. According to Baudrillard, "Reality is exiled from Reality," and rather than seeing technology as a factor that isolates people from reality, he believes that it may be the only thing that still unites reality's fragmented components.

Multidisciplinary and interdisciplinary research methods have become increasingly popular in recent years. Modern, very dangerous forms of warfare, rapacious resource extraction, environmental degradation, technological acts of brutality, undiscovered genetic alterations, and numerous other unsettling occurrences are the results of the aforementioned. By building atomic power plants, man has created many comforts for himself. However, we have witnessed catastrophic failures at two such nuclear power plants, at Three Mile Island in the US and at Chernobyl.

Science played a crucial role in the creation of the atomic bomb. The development of the atomic bomb was a multidisciplinary endeavor that required the coordination of different scientific fields such as physics, chemistry, and engineering. Scientists worked tirelessly to unravel the mysteries of the atom, with the aim of harnessing its energy for destructive purposes. The Manhattan Project was the codename for the secret military project that produced the first atomic bombs during World War II. It involved the collaboration of renowned scientists such as Robert Oppenheimer, Enrico Fermi, and Albert Einstein, who provided critical insights into the scientific principles underlying the atomic bomb's creation. Scientists developed various technical procedures that helped refine the atomic bomb's design, reducing its weight while increasing its destructive power.

Science played a key role in the atomic bomb's development, raising ethical questions about the possible consequences of its use. The bombing of Hiroshima and Nagasaki resulted in the death of many people and caused long-term effects such as radiation poisoning, cancer, and environmental damage. The development of the atomic bomb highlights the power of science to both create and destroy, emphasizing the need to use science responsibly in advancing human civilization (Temkov, 2020).

Ethics as an indispensable part of science

After World War II, several codes of ethics were established to regulate scientific research. The Nuremberg Code, adopted in 1947, was a set of guidelines for conducting medical experiments on human subjects. The Declaration of Helsinki, adopted in 1964, expanded on the Nuremberg Code and set guidelines for medical research on human subjects. The Belmont Report, adopted in 1979, established guidelines for research involving human subjects in the United States. These codes have helped to ensure that scientific research is conducted ethically and with the aim of improving the lives of people.

When talking about social values, researchers first and foremost lay a strong focus on ethical standards, which highlight moral responsibility for one's own conduct as well as for the behavior of other study participants. The majority of researchers uphold fundamental ethical standards in science, and unethical behavior is not typical of scientists (or at least it shouldn't be), yet there are certain people who are simple to deceive.

Today's improvements in worldwide social development, especially in the most economically advanced countries, are primarily due to developments in science and technology. In addition to the positive effects that technology has had on the expansion of all aspects of social life, it has also had severe effects, notably on the environment. "Man created scientific technology to enhance productivity and volume of output, but he didn't anticipate that using it would have such negative effects on the environment and its ecological systems as well as on the resources consumed" (Vićentijević, Aćimović

and Stevanović, 2011). The question is rightly raised whether the progress of science leads to progress or regression of humanity. The first scientific-technological revolution led to a decrease in the number of employees, because they were replaced by machines, while the current scientific-technological revolution, almost certainly, will deprive people of the ability to think.

One of the most famous Serbian writers of the 20th century, Borislav Pekić, has long warned about the problematic nature of artificial intelligence, more precisely about the problem of developing its emotionality. He divided science into black and white - permissible and impermissible science. White science refers to everything exact and true in science, which does not engage in dangerous, uncertain and staged experiments, aimed primarily at the well-being of man.

Corporate scientism, which has abandoned the aim of service to man and mankind and has put itself at the service of profit without regard for means or methods, is what we refer to as "black science." Today, unethical and unscrupulous lobbying permeates practically everything. The Nobel Prize has become worthless to many, and several Scandinavian activists filed a criminal investigation against committee members for disrespecting its founder's legacy after the peace prizes were awarded to Obama, Chinese dissident Liu Xiaobo and the European Union. After only nine months in office as US president, at a time when the US was engaged in two wars - in Afghanistan and Iraq, as well as during increased drone attacks in Pakistan and Yemen, Obama was awarded the world peace prize "for outstanding efforts" in order to strengthen international diplomacy and cooperation between nations. Recently, huge amounts of money have poured into American institutes, whose "unbiased studies" increasingly coincide with the interests of foreign donors. One such example is the Center for Global Development, which received a large sum of money from Norway to influence the US to double foreign aid, praise its prime minister and nominate him as the next head of the NATO alliance. Another example is the Japanese, who also donated over 1.1 million euros to publish studies concluding that the US should negotiate a free trade agreement with Japan. These are academic groups that present themselves to US officials as "objective" organizations, "untainted" by interests, and often their studies carry more weight than the persuasion of proven lobbyists, interest groups or lawyers.

Scientists frequently run into issues that are brought on by "various power centers, important people, politicians, strong social institutions, and the like" (Vučković, 2022). We may use the dominant worldwide pharmaceutical industry as an example, which invests much in science, research, and the development of new drugs but is also the target of countless rumors of unethical behavior and immoral acts (Dašić, Tošić and Deletić, 2020). Investment experts anticipate that the American biotech company Moderna, the German biotech company Biontech, and their joint venture partner, the American pharmaceutical behemoth Pfizer, will generate billions of dollars in revenue in 2019. The Moderna vaccine's development is said to have cost roughly $ 2.5 billion in total, with the consensus being that "American taxpayers funded for 100% of that development. Support for the Moderna vaccine, which according to testing is 94.5% effective, comes from a number of organizations, including Emory University, Vanderbilt University Medical Center, and the Dolly Parton Research Fund. "All vaccine-related transactions are covered in secrecy, and businesses and government agencies are protecting their right to privacy" (Clouse, 2021). Drug companies have been reluctant to discuss the price of a single dosage of a vaccine, despite the fact that the government has committed billions of dollars in its development.

Military innovations significantly lower people's quality of life. The majority of them are instruments for mass destruction of both people and objects. Biological weapons have been developed using bacteria that cause diseases including anthrax, smallpox, and biotoxins. Additionally, brand-new biological weapons are being created, principally using the most recent genetic engineering and genetics expertise. Many scientists' consciences were deeply affected by the development of the atomic bomb because of the suffering that resulted from its deployment at the conclusion of the Second World War. Following that, a number of ideas for the peaceful use of atomic energy emerged, which caused millions of people to become wealthy and, as a result, feel less guilty. This method is still utilized today, thus space exploration is done in conjunction with military objectives by installing strong military satellites that, aside from being used for more effective and faster global communication, are primarily used to wage war and commit murder.

The link between man and nature, or their life interconnectivity and conditioning, has been a continuous companion of human history since human life is a part of the natural cycle of life and production is the taking and processing of natural materials to fulfill human needs. "Man's impact on environment, however, takes on a distinct character in pre-industrial civilization, which is dominated by agriculture, cattle, and crafts" (Marinković, Marinković and Stefanović, 2013). With his manufacturing and other actions, man has an impact on and modifies nature. But these modifications are only made locally, just in the areas where people construct their homes or harvest natural resources for their personal purposes.

This interaction between man and his surroundings does not call into doubt the natural equilibrium.

Preservation of the environment has become an increasingly pressing issue in recent years. With the rapid expansion of human activities and the subsequent rise in pollution levels, it is imperative that immediate action is taken to protect our planet. The preservation of the environment is crucial because it directly impacts the health and well-being of all living organisms, including humans. Our planet provides us with essential resources such as clean air, water, and food, and it is our duty to conserve and protect these resources for the benefit of all. Moreover, a healthy environment promotes biodiversity and ecological balance, contributing to the overall sustainability of our ecosystems. By preserving the environment, we can ensure the continuity of life and avoid irreversible damage from pollution, deforestation, and global warming. The consequences of neglecting the preservation of the environment are severe and far-reaching. Continued degradation of the environment will lead to an increase in air and water pollution, which can have detrimental effects on human health and the natural world. Climate change, resulting from excessive carbon emissions, will bring about more frequent and severe natural disasters, such as hurricanes and droughts. Furthermore, the loss of biodiversity due to habitat destruction threatens the delicate balance of ecosystems, impacting agricultural productivity, food security, and ultimately human survival. Neglecting environmental preservation would jeopardize not only our own future but also the well-being of all other species with whom we share this planet. To ensure a sustainable future, Scientific workers and researchers. must take action and promote environmental preservation in their daily lives. This can be achieved through simple measures such as reducing waste, conserving energy, and supporting sustainable practices in our consumption patterns. Additionally, spreading awareness about the importance of environmental preservation through education and social activism can create a positive ripple effect, inspiring others to join in the cause. By participating in environmental organizations or engaging in research related to environmental issues, college students can drive meaningful change and contribute to the preservation of our planet for generations to come.

Scientists are expected to make a significant contribution, to listen to predictions and align their intended big undertakings with them and to respect the dangers caused by industrialization, excessive burning of petroleum derivatives in the automotive industry and in factory plants because all of this can have catastrophic consequences for the overall life on planet Earth. In the last decade, it has been proven that the stratosphere has been introduced into the phenomenon of the so-called greenhouse due to the excessive production of carbon dioxide and the reduction of ozone, resulting in ozone holes. The ozone layer protects against excessive penetration of infrared rays from the solar spectrum on the earth's surface. The depletion of the ozone layer in the stratosphere is caused by the excessive use of chlorofluorocarbons and the burning of petroleum products. Chlorofluorocarbon was used in the industry of refrigerators and sprays and, following the warnings of scientists, it was banned by a UN decision made in 1995 to stop the greenhouse effect (Nenadović, 2007).

The debate over the socio-ethical boundaries of science is centered on the tension between the legitimate right to freedom of inquiry and the need for outside controls to mitigate the risks of inquiry—which, for instance, could endanger the right to life, the quality of life, or the preservation of the environment. „The participation of the scientific community in defining the risks associated with modern technology cannot be replaced, but decisions concerning their management require discussions beyond disciplinary boundaries, as well as the exchange of data and arguments from different scientific and non-scientific perspectives" (Develaki, 2008; Doemeny and Knerr, 2017).

Conclusion

Science has greatly influenced the progress of civilization over time, always increasing its material and spiritual possibilities. This affected and helped to establish modern civilization and the conditions for a secure and satisfying existence. Every country in the globe is still growing, mostly because of science and emerging technology. However, because changes occur so fast and dramatically, it is challenging to keep up with them. It is also challenging to recognize how changes affect us all on a daily basis. Even worse, a lot of scientific advancements and technology are kept a secret in order to retain economic and military superiority.

It is believed that the development of, say, moral principles in science is significantly influenced by the scientist's sense of personal responsibility as well as the sensitivity he developed during his education for moral issues related to the choice of research subjects and the dissemination of his knowledge for practical application. Another, equally important factor is the willingness and commitment of the scientific community to expose cases of risky research, misuse of scientific knowledge by certain groups, or to raise

public awareness of the possible costs to society of the risks associated with technological applications. Of course, it can be countered that there are always positive and bad outcomes in research and that any attempt to completely separate them would probably result in the stagnation of scientific progress.

Science undoubtedly opens new doors and provides people with inspiration and tools to build and progress, but it also poses a threat to all life on Earth. This, however, is not a direct moral output of scientific thinking and activity, or even very seldom a direct consequence thereof; rather, it results from people's negligent exploitation of scientific knowledge. The ethical conduct of research is crucial for many types of undertakings, not only those involving scientists. In order to meet new health, environmental, and technological concerns and consequently enhance quality of life, society as a whole depends on innovation across many fields. Due to speedier advancements in science, medicine, a more enjoyable way of life, and economic success, or an improvement in the general quality of people's lives, the average lifespan has grown during the previous two centuries. Despite this change's undeniable significance and importance, which may seem contradictory, it has nonetheless led to a rapid rise in the world's population, and this change has had numerous negative direct and indirect effects on the environment and ecosystems that are harmful to people.

Ethics and science are crucial for the development of human society. Ethics guarantees that our scientific discoveries remain sustainable and responsible even when science provides us with information and tools for progress. For humanity to progress without harming itself and other living beings, these two sectors must be recognized as interconnected and mutually influencing.

Conflict of interests

The authors declare no conflict of interest.

Author Contributions

Conceptualization: D.D., Formal Analysis: D.D., M.S., G.K., Investigation: M.S., Methodology: D.D., M.S., Project administration: D.D., Resources: G.K., Writing – original draft: D.D, Writing – review & editing: D.D., M.S., G.K. All authors have read and agreed to the published version of the manuscript.

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