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ENGINEERING SUSTAINABILITY

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ABSTRACT

If human activity and growth are to continue, sustainability must be everyone's top priority. Due to 1) the pervasiveness of engineering activities in societies, 2) their significance in economic development and the improvement of living standards, and 3) the significant negative impacts that engineering processes and systems have had and continue to have on the environment, engineering sustainability is crucial for any plans for overall sustainability. This article examines a variety of problems that must be studied and addressed in order to attain sustainability in engineering. Examples of what is being done include the use of sustainable engineering approaches, improved engineering process and resource efficiency, and a comprehensive approach to environmental stewardship in engineering activities.

1. INTRODUCTION

Technology, sometimes known as engineering, is the application of scientific and mathematical principles to practical problems, such as product design, manufacture, and operation, while taking into account economic, environmental, and other societal restrictions. Engineering is a diverse field with numerous subdisciplines. Numerous technical advancements can be credited to engineering. The engineering profession has a substantial impact on the development of a society's culture and environment, as well as its economic development, living standards, and well-being. Throughout history, engineering as a profession has evolved [1, 2], and engineering education has evolved in tandem [3]. Sustainable development is becoming an increasingly popular objective for many governments worldwide, especially in poorer nations. Environmental, economic, and social sustainability are seen as three distinct aspects of overall sustainability, which can be defined in numerous ways. Individually, these three variables have the potential to steer civilization in three divergent paths (e.g., economic sustainability may be achieved at the expense of environmental and social sustainability). To attain comprehensive sustainable development, sustainable development must be accomplished at all levels of society, including environmental, economic, and social sustainability. Obtaining this equilibrium is a challenging endeavor. Engineers have no direct ties to any of the aforementioned three sustainability factors, yet they are intricately linked to all three. In other words, engineers are responsible for the vast majority, if not all, of worldwide economic activity, which occurs in practically all economic sectors, such as industrial, transportation, residential, and commercial, to mention a few. In addition to designing and developing new technologies, engineers are also responsible for their creation. In addition, engineering resources such as fuels, minerals, and water are obtained from the environment, whereas engineering wastes (made during the manufacturing process, transported, stored, and utilised) are often released into the environment. Finally, engineering services are often related with the promotion of social stability and cultural and social development, as well as the improvement of living conditions. As a result of the strong linkages between engineering and the basic components of sustainable development, it is evident that achieving engineering sustainability is a crucial component of achieving sustainable development in individual countries and globally. Regarding the significance of sustainability, Kreith [4] asserts, "there is no issue that is more essential to the engineering profession or to the greater environment in which we live.". All countries requiring engineering services and consuming resources, engineering processes having local to global environmental impacts, and the increasing globalization of the world's economy point to a global push for sustainable engineering. In this sense, engineering sustainability is viewed as a broad notion. In other words, engineering sustainability is the application of engineering principles to systems throughout time. Included in these systems are methods and technology for collecting resources and transforming them into useable forms. Sustainability in engineering is not well understood or acknowledged, despite its critical importance in modern society. The author,

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Kreith [4, adds that "engineers are still attempting to appreciate how sustainability relates to our field." As he continues, he says, "It is reasonable that engineers struggle with sustainability because there are no formulas that can maximize it and no generally accepted norms that we must adhere to." In practice, though, the concept is quite unclear. In order to achieve engineering sustainability, the goal of this paper is to identify and investigate the critical factors that must be considered. However, the hunt for sustainable materials is simply one part of sustainable engineering. The design and implementation of environmentally friendly infrastructures, such as the use of renewable energy sources and environmentally friendly transportation modes, is a further component. enables us to integrate sustainability into a variety of societal areas, including government. From a purely pragmatic standpoint, an example of a hypothetical future sustainable engineering project is offered.

2. SUSTAINABLE DEVELOPMENT AND SUSTAINABILITY

Examine the definitions of sustainability and sustainable development to gain a deeper understanding of the concepts that underpin engineering sustainability in the building industry. The Brundtland Report, published by the World Commission on Environment and Development in 1987, defines sustainable progress as "development that meets present needs without compromising the ability of future generations to meet their own needs." According to this theory, the actions of contemporary society should not jeopardize the cultures and living conditions of future societies. Additionally, additional additions have been made to the definitions and descriptions. In varied degrees, size, wealth, living standards, culture, and political and administrative systems influence a country's capacity for sustainable development. In addition, countries vary in their capacity to achieve sustainable development. Due to their wealth and technological superiority, industrialized nations may find it easier to pursue sustainable development than underdeveloped nations, but this is not always the case. Countries, governments, civilisations, and individuals appear to have kept their core motivations and goals for progress, and these goals are frequently attained through increasing engineering, resource consumption, and emissions.

3. ENGINEERING AND THE ENVIRONMENT

The application of engineering affects every area of life in every country, and it is only through this application that human civilizations have a chance of survival. Local and regional engineering applications and resources are produced in response to the specific requirements of particular communities and locales. In numerous nations, engineering-related elements have a regular impact on the standard of living of the populace. In recent years, there have been an increase in the number of efforts to make engineering activities more environmentally friendly, as well as efforts to define engineering sustainability. As opposed to the application of sustainability concepts in other domains, engineering sustainability is the application of various sustainability principles to the engineering discipline. Long-term sustainability engineering is more complex and involves more individuals in diverse capacities. This implies that in order for engineering to be ecologically sustainable, it must deliver engineering services to all people in ways that are sufficient to meet their essential requirements, inexpensive, environmentally friendly, and acceptable to communities and people in the present and future. Contrary to some cyclical traits, this definition stresses a number of engineering sustainability's most essential aspects. Engineers are still grappling with the meaning of the term "engineering sustainability."

There have been engineering-related sustainability definitions proposed [4–18] for specific industries, such as energy, but no universal consensus has yet been reached. There are numerous linkages that may be made between the notions of energy and engineering sustainability. Rosen [5,6] defines energy sustainability as the supply of energy services for all people in a manner that is sufficient to meet fundamental needs now and in the future, cost-effective, does not harm the environment, and is acceptable to communities and individuals. Interest in the numerous facets of technological sustainability, as well as the concept of sustainability in general, is gaining popularity among engineers. Research on sustainability engineering (and sustainability science) is fully covered in [19], whereas Kajikawa [20]

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explores engineering sustainability research in depth (together with sustainability science). Several studies [22–23] have examined the theory and practice of sustainable engineering, and one study [21] provides a conceptual framework for the development of sustainable engineering systems. The use of engineering to problem-solving in the context of sustainability is the subject of research [25], and a handbook for sustainable engineering and design is in the process of being [26]. The relationship between sustainable development and professional practices is investigated in this research. [27] Consider as an example the sociotechnology of creating long-term viability. The use of natural resources responsibly and the establishment of acceptable indicators are investigated in depth [28]. [29] This study examines the use of engineering sustainability to enhance efficiency. Hammond [30] has adopted a sub-disciplinary approach to engineering sustainability, examining it from the perspectives of thermodynamics and the environment. Several scholars, notably Bakshi and Fiksel [31], have studied the problems of process systems engineering in the context of a broader push for sustainability. Numerous industries have examined [32] and applied [33,34] sustainable manufacturing and design concepts, processes, and criteria. Energy processes and utilization have been the subject of extensive research [5, 6, 36], with methodologies for evaluating the sustainability of a national energy conversion system proposed and applied to Canada [37, 38] and the sustainability aspects of energy conversion in urban electric trains investigated [39]. Also recorded is the use of sustainable solutions to large-scale engineering projects, such as the sustainable development of the Red-Mediterranean-Dead Seas Canal project [40]

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