Example of implementing industrial sustainability research paper

[Education](), [Sustainability]()

Abstract

Sustainability of engineering systems forms the fundamental principle that guides actions and decision-making activities in any organization. Meeting current without compromising future needs is the overall goal of sustainability. Sustainability is also critical when making a trade-off among social, economic, and environmental goals. However, sustainability is yet to be realized in industrial ecology due to several challenges that impede its implementation. For this reason, sustainability within the industrial environment forms the basis for this paper.

The rise in industrialization and increase in population coupled with the effects of globalization have generated an increased need for sustainability. According to the World Commission on Environment and Development (WECD), sustainability entails the process of realizing current needs without compromising the capabilities and opportunities of future generations in realizing the same needs. Similarly, the Lowell Centre for Sustainable Production defines sustainable development, as the process of creating goods and services using clean processes and systems that are economically viable, non-polluting, safe, and healthful to all people. Sustainability is no longer a term associated with the management of resources and the environment but rather a concept that is applicable in many societal concepts.

In an industrial environment, sustainability of engineering systems forms the fundamental principle that guides actions and decision-making activities in any organization. It forms a key organizing design principle for manufacturing engineering when it comes to making a trade-off among social, economic, and environmental goals (Chang Chapter 2). It is emphatically crucial to note that sustainability is not a property that can be measured analytically or implicitly but rather a property achievable by adhering to several indicators. The treatment of manufacturing systems plays a significant role in determining sustainability and other interrelationships with key subsystems. For this reason, industrial sustainability entails the ability of replenishing key components of manufacturing systems, manufacturing inputs, and other evaluation dimensions throughout the manufacturing period.

Incremental improvements in industrial processes can be realized through the optimization of their industrial ecologies. This entails setting up standard systems and processes, establishing the evaluation criteria, and generating list of solutions ((Allam, and Houle 119). Industrial ecology in this situation refers to the framework that guides the process of transforming industrial systems from a simple linear model to a closed-loop model resembling a cyclical flow of ecosystems. Such systems enable wastes from one system to form basic nutrients in the other system. Manufacturing processes involves the elimination of wastes and hence, industrial ecology argues that innovative pathways should be designed to guide the process of converting wastes into more useful by-products (Ashford, & Vergragt). This concept enables companies to discover valuable opportunities to assist the process of creating value.

Overview of sustainable systems

A system is composed of a set of elements that work together to deliver common goals and in the process improving the overall level of functionality (Chang Chapter 2). Each system element has a set of attributes with relationships that serve to aggregate them. Industrial systems are driven by engineering designs and technological innovations and hence, change in such systems is ubiquitous. To keep up with this pace, institutional changes must be undertaken to ensure sustainability of these industrial systems (Chang Chapter 2). Given that industrial sustainability revolves around systems, it is critical to identify the dynamics of system changes to prevent the creation of unsustainable future trends. Such system changes cover both institutional frameworks and physical systems within the manufacturing environment. Focusing on system design, operational procedures, and planning enables the realization of the overarching goal of industrial sustainability (Mitsuishi and Kimura 12).

The system approach aids in the design of industrial product and service systems in order to realize sustainable development (Chang Chapter 2). While traditional manufacturing systems might have adopted sustainable goals, the development of sustainable systems has remained a challenging objective given the plethora of broad environmental, economic, and social factors that needs consideration throughout the system life cycle. The manufacturing industry is known as one of the leading sources of environmental degradation and centre for creating social problems even though it forms a principle source in generating wealth.

Dimensions of Sustainability in a manufacturing environment

Generally, three dimensions or pillars are used to measure sustainable development and these are economic, environmental, and social dimensions. These dimensions are interrelated in the sense that the environment dimension forms the basis for sustainability while the economic dimension provides the necessary tool for achieving this dimension. Similarly, the social dimension or the good for all principle provides the target for sustainability (Fennema 40).

Environment

Manufacturing activities have created increased strains to the natural environment because industrial activities and processes influence the balance of the ecosystem. Securing sustainable ideas to help in the minimization of global warming and Greenhouse emissions, control chemical pollution, and aiding the return of natural nutrient cycles should form the overriding principle towards sustainability. Since the environment forms the basis for realization sustainability, it is logical to control all manufacturing activities to prevent the environment from coming out of balance. In the process, the good life will be created in addition to availing all economic necessities (Fennema 41).

Economic Dimension

Economic prosperity is an important element in achieving sustainability because it enables individuals to eradicate poverty, bring economic development, and financing challenges. Therefore, economic growth in a sustainable environment forms a part of sustainable development and improved eco-efficiency. Implementation of economic policies, legislations, and creating economic awareness provides the essential tools for facilitating economic development. Sustainability from the economic dimension entails creation of sustainable investments in all economic sectors, investing in knowledge and solutions for the realization of sustainable development, and identifying ways of influencing consumption decisions (Centre for International Manufacturing).

In a manufacturing environment, accountability of all environmental costs and social costs in manufacturing processes facilitates sustainability. Trading environmental and social costs are directly reflected in market prices when trading is based on real costs.

Social Dimension

Sustainability is the overriding concern for future generations and it involves shifting focus to the provision of good life to all human. This shows that the social dimension forms the overall target of sustainability. The underlying assumption for sustainability is achieving equity for all members in the society. Ways of realizing sustainability within the manufacturing environment involves responding to concerns for raw materials, addressing consumer and worker concerns, focusing on corporate social responsibility, and enhancing lifelong learning and training.

Government Regulation

Governmental regulations are highly instrumental in influencing manufacturing processes in addition to developing a proactive attitude towards the realization of sustainability. A certain level of regulation of manufacturing patterns enables aids the three dimensions to yield sustainability. For instance, governmental authorities can put certain measures on these dimensions to influence the process of realizing sustainability. An elimination of restrictions on access to raw materials can boost the economic dimension whereas the implementing a framework that focuses on social welfare will facilitate the realization of the social dimension.

Excellence and Sustainability

Strengthening the level of competitiveness in manufacturing processes calls for the creation of innovate, safe, and environmentally friendly products. For this reason, all manufacturing systems should be capable of delivering high quality and innovative products are reasonable costs. This explains the concept of excellence in manufacturing processes. To maintain, reach, and attain this level of excellence, several key requirements must be fulfilled. This means that sustainability should be efficient, high quality, flexible, and environmental friendly (Hesselbach 81). Therefore, excellence in manufacturing processes requires attaining high productivity, high quality, and competence (Hesselbach 82). Additionally, manufacturing systems should be capable of developing a diverse range of product models using the same production system.

Resilience and Sustainability

According to the systems theory, complex systems are capable of interacting openly within their constituent environments and in the process; they evolve continually and acquire new properties (Fiksel 5332). The system theory studies the relationship between the constituent parts of a system and their independence. However, some manufacturing systems are resistant in order to maintain a stable state throughout the production process. Generally, manufacturing systems operate within a narrow band that is designed to provide resistance to perturbations (Fiksel 5332). On the other hand, a resilient system is one that functions across a wide spectrum of possible states and shows gradual tendencies to return to the original equilibrium state. Such a system develops adaptations that enable it to survive large perturbations. A resilient system is more advantageous than a resistant system and hence, sustainability of manufacturing systems should be achieved by manufacturing by applying the concept of resilience in the system design (Fiksel 5332).

Challenges to implementing sustainability in a manufacturing environment

While the concept of sustainability forms the agenda in many societal issues, achieving this objective in the industrial environment has eluded many stakeholders. First, the rising population has created increased demands from the manufacturing industry thereby creating a strain on natural resources. With such increase in global population, there is a high likelihood of severe shortages on resources needed to support human needs (Huesemann 13). Depletion of non-renewable sources of raw materials for is another leading challenge that has impeded the process of realizing sustainability in the industrial environment. The lack of eco-efficiency also forms another major problem in preventing the realization of sustainability (Huesemann 14). Development of industrial and engineering systems that support sustainability should a subject of concern for many developers (Paramanathan, and Farrukh 528).

Low research initiatives to aspects relating to the management of industrial technologies have contributed to the low pace of realizing sustainability. This has led to lack of effective identification of sustainable technologies, poor selection, and acquisition of production technologies, excessive exploitation of resources, and lack of implementing protective mechanisms to govern such technologies. Other areas that have seen minimal development include long-term industrial planning, slow response to change, and poor technological assessment tools, management issues (Mitsuishi and Kimura 12). Low research and development, poor knowledge sharing and lack of technological transfer are other major impediments to the achieving sustainability. Advancements in technology have been in the rise over the recent past thereby creating a wave of disruptive technologies. Worse, the form of future technologies is unknown yet thereby posing more challenges.

Indicators/Metrics for Measuring Sustainability

At present, metrics of measuring sustainability tend to revolve on the striking a balance between environmental, social, and economic aspects of the society. For environmentalists, it is quite easy to limit their measurement to specific species as compared to measuring collective aspects of biodiversity (Jain 71). On the other hand, economists use quantitative and objective indicators when measuring sustainability. However, it is difficult to measure sustainability from the sociological perspective due to the lack of intangibility of different life issues.

Indicators for measuring the economic dimension include Gross Domestic Product, and Sustainable Economic Welfare (ISEW) developed by Cobb and Daly. The ISEW has further been enhanced to be the Genuine Progress Indicator and it considers negative effects to consumption. Indicators for measuring the social dimension are largely related to the environmental and economic indicators and are based on key aspects such as program evaluation, problem orientation, information, and target delineation. Similarly, indicators for measuring environmental aspects measure the different aspects of the working environment such as on land, air, and water. A good example is the ecological footprint that is mostly used in developed countries and urban societies.

Other tools of assessment and analysis for sustainability include cost-benefit analysis (CBA), Simulation models (SM), Forecasting Models (FM), Integration Modeling Systems (IMS), Optimization Models (OM), and Management Information Systems (Chang Chapter 3).

Conclusion

Undeniably, the global population is expected to grow at an increasing rate hence exerting pressure to the natural resources. The existence of unsustainable engineering systems is likely to contribute to the worsening state of environmental resources. Social and physical systems are expected to play a contributory role in developing and sustaining the development of industrial activities. Therefore, it is critical that all industrial systems be developed and designed in such a way that contributes to the maximization of sustainability (Yeralan and Baker).

Education systems and programs need to be reviewed in order to foster a sustainable mindset among future engineers. This will entail widening the concept of engineering education and developing research programs that address key areas relating to sustainability. This factor will enable engineers to envision future scenarios and come up with system designs that are not only flexible but also those that support the objective of attaining industrial sustainability. As we fight against impediments to environmental, economic, and social development, engineers need to develop a mindset that enables them to develop systems and programs that leads to sustainable transformations. Creating sustainable engineering systems forms a fundamental principle in the organization of design principle and as well in creating a trade-off among social, economic, and environmental goals. For this reason, several tools of analysis and indicators from all dimensions should be considered when developing sustainable engineering systems. In turn, the overall goal of achieving industrial sustainability within the manufacturing environment will be realized.

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