Chapter 5
Diffusion and Adoption of Innovations for Sustainability

Helen E. Muga
University of Mount Union, USA

Ken D. Thomas
Auburn University, USA

ABTRACT

The primary focus of this chapter is on the theory and concepts of sustainability and why they are important to innovation and vice-versa. Key reductionist approaches to assessing sustainability such life cycle assessment (LCA), life cycle cost analysis (LCCA), and sustainability indicators are discussed in detail and applied to an engineering infrastructure scenario. The integrated sustainability methods of life cycle assessment and life cycle cost analysis enable a business to assess alternative products or processes at the planning and design stages. They may also be used during the production stages to assess whether a business needs to use a different raw material to make their products. The role of management, social network analysis, and mental models of individuals in the diffusion and adoption of innovations are also explored.

INTRODUCTION

Over the centuries, energy consumption has increased from 10 quadrillion BTU (10.055×10^{18} joules) in year 1800 to 500 quadrillion BTU (5000×10^{18} joules) in year 2000 (UN Environment Programme, 2007). Population, carbon dioxide emissions, water use, amounted of domesticated land, loss of tropical rain forest and woodland, and nitrogen flux to coastal zones have also increased over time. Population increased from 600 million in year 1750 to 6 billion in year 2000. Carbon dioxide emissions increased from 250 ppmv in year 1800 to 360 ppmv in year 2000. Water use increased from 200 km^3/year in 1900 to 5000 km^3/yr in 2000 and nitrogen fluxes increased from 0.25×10^{12} moles/year in year 1850 to 9×10^{12} moles/year in 2000 (Crutzen, 2005). Unsustainable

DOI: 10.4018/978-1-61350-165-8.ch005

practices such as excess consumption, unsustainable management practices exacerbate current global problems. These global challenges/issues are intricately linked to one another. Figure 1 shows the interaction between population, natural resources and services, energy, emissions, and climate change.

The introduction, and the diffusion and adoption of sustainability concepts and theory to a large extent attempts to address current global challenges that society and future generations face by reducing excess consumption, promoting efficient management and use of natural resources, and reducing consumption of energy sources that contribute to climate change The term "sustainability" has different meanings to different people. One of the definitions of sustainability is that it is "development that meets the needs of the present without compromising the ability of future generations to meet their own needs" (Brundtland, 1987). At the business level, sustainability is defined as, "meeting the needs of a firm's direct and indirect stakeholders (such as shareholders, employees, clients, pressure groups, communities etc), without compromising its ability to meet the needs of future stakeholders as well" (Dyllick & Hockerts, 2002).

In this chapter, we focus on the theory and concepts of sustainability (life cycle assessment, life cycle cost analysis, and indicators) and their application to the built environment. In this chapter, we focus on the theory and concepts of sustainability (life cycle assessment, life cycle cost analysis, and indicators) and their application to the built environment. The built environment includes "all of the physical structures engineered and built by people—the places where we live, work, and play. These edifices include homes, workplaces, schools, parks, and transit arrangements" (Dearry, 2004). They also include roads, power generation facilities, harbors, treatment plants, bike paths, and storm-water management systems. These engineered structures sustain and support human activity and continuity. The built environment is one of the largest consumers of raw materials and energy. Over three billion tons per year of global raw materials (40%) are consumed in the United States (U.S. Green Building Council, 2005). Commercial and residential buildings consume around 36% of energy and over 65% of electricity in the U.S. (U.S Green Building Council, 2005). Further, construction, renovation, and demolition of buildings contribute a significant amount to total solid waste in the U.S. and around the world. In 1997 alone, construction and demolition waste amounted to 65% of all solid waste in the U.S (U.S.EPA, 2000).

We also focus on the role of management in the diffusion and adoption of innovative strategies that contribute to sustainability and drive it over the 'tipping point- defined as the point at which an object is displaced from its current state (of trajectory) into a new state (of trajectory). Of great importance are the types of strategies that businesses and various entities adopt and their impact on sustainability. For example, do the innovative strategies that are adopted drive the business toward sustainability or away from it? A great deal of emphasis is given to the role of learning and its impact on the change in mental models of individuals as these play a critical role in the adoption and diffusion of innovation.

OVERVIEW OF SUSTAINABILITY AND SUSTAINABLE DEVELOPMENT

While there are varying definitions of sustainability from different sectors of industry, what is important is that it strives for protection of the environment, prudent use of natural resources, equitable social progress, and maintenance of economic well-being without compromising the environment and society. Figure 1 shows the three dimensions of sustainability. Long-term strategies towards achieving sustainability should consider all three aspects (i.e. the whole or complex system), either at the decision stage or during the operational stage.