Chapter 27
Design for Sustainment: Challenges and Theoretical Issues in Product and Global Supply Chain Management

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ABSTRACT

The purpose of this chapter is to chronicle and analyze existing challenges and theoretical issues in the domain of product, system, and the emerging area of global supply chain sustainment. These challenges encompass the provision of reliable, efficient, cost-effective, and quality services by key players and major stakeholders in product and global supply chain. The authors argue that sustainment concept serves as a vehicle for elevating the rate of product and system utilization. This will have a tremendous impact at reducing the burden of product or system's operational issues thereby allowing for the leveraging of the enormous potentials of sustainment. Both contemporary as well as classical journal papers and publications are included in this study to trace and describe the development, state of sustainment perspectives, available tools, and methodologies in product and global supply chain system sustainment.

INTRODUCTION

Designers of products or systems are often saddled with the responsibility of designing sustainable products or systems despite well-known recurring problems. While improvement in design processes seems to have been ameliorated, some of these problems and challenges are still in existence. SCDigest Editorial Staff (2010) identified five challenges of today's global supply chain as supply chain volatility and uncertainty, complexity of managing increased supply chain globalization, the critical nature of cost-optimized supply chain, global risk management and the issue of global supply chain integration. There is also the dearth of robust systems or frameworks that captures

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pertinent and verifiable life time data, the lack of consensus among product or system designers about how to go about achieving sustainment, difficulty arising from various product usage environments, complexity of product or system design options and lack of coherent method for defining design parameters, and so on, still loom large.

Castillo (2010) discussed the changes that took place in the distribution of large volume of gasoline during the early days of the United States Army's Operation Iraqi Freedom (OIF) in 2003 and cited the need for more collaboration among strategic partners due to the increased storage and distribution requirements for gasoline and other petroleum products. Shaked and Jolliet (2011) stated that with increasing globalization, goods are now produced outside their area of consumption. To ensure progress is sustained, the authors noted that it is becoming crucial to assess and minimize all the global environmental health impacts associated with global production chains and consumption in those different areas. To address this challenge, they identified lifecycle assessment (LCA) as a veritable decision support tool that can address this issue.

These issues confronting product and global supply chain system appears to be founded theoretically but in practice, a major challenge will be predicated on how best to design sustainable products and systems using real time data in dynamic operational environment. These unresolved problems will continue to be the subject matter for future research undertakings. In the short run, the current research efforts are critiqued to create a basis for establishing a methodology that will guide the design of sustainable products and systems in varied dynamic operational environments.

Sustainability is bio-centric in nature. As a result, it recognizes the interplay of various socio-economic and ecological systems on a short rather than on a long term basis. Cutcher-Gershenfeld et al (2004) defined sustainability with respect to trade-offs among economic development and social and environmental goals. It is generally a broad concept not just viewed as the environment and resources any longer. The authors advocate that systems must be sustainable on environmental, economic, developmental and social and political dimensions In essence, sustainability robustly relates to the capability to replenish or retain major characteristics, resources and inputs over a period of time. As more organizations commit to supply chain sustainability, there is urgent need to devise long term sustainment strategies as against short term, quick fix or stop gap strategies offered by current practices. This will require the incorporation of lessons learned throughout a product or system's operational lifecycle in the early design stage decisions and utilize them in the design of global supply chain sustainment framework. This proactive strategy can substantially enhance global supply chain long term sustainment through reduction in lifecycle costs, information access and operational efficiency and effectiveness.

The primary focus of this research is on product and global supply chain system supportability practices and how these practices can apply to the sustainment of product and global supply chain systems operational performance. The remaining paper is organized as follows. The next section gives an overview of the concept of sustainment and sustainability as well as the historical background of sustainment concept. The subsequent section presents a brief review of related literature on various sustainment frameworks, practices and challenges confronting product and global supply chain dominated-systems. Sustainment and product design parameters are introduced in the next section. Next, design for sustainment stakeholders is discussed. This is followed by a description of high-level design for sustainment. Challenges facing product and global supply chain sustainment are highlighted. Finally, the summary section makes a case for discussion and inclusion of the concept of sustainment in the overall product and global supply chain framework by incorporating engineering design and technology tools to address various lifecycle, management, logistical and supportability challenges.