CHAPTER – 1
INTRODUCTION

The chapter introduces the concept of environmentally conscious manufacturing and the importance of performance measurement. The background, scope and objectives of the study, and methodology adopted for carrying out the research work is also presented in this chapter.

1.1. INTRODUCTION

With growing awareness of environmental issues – from global warming to local waste disposal and pollution problems – business and government have come under increasing pressure to reduce the environmental impacts involved in the production and consumption of goods and services. Until quite recently the usual response to environmental problems involved measures to reduce pollution and waste after they had been produced; for example, by installing flue gas desulphurization equipment in a power station or waste water treatment plant in a factory or adding catalytic converters for cars or banning sale of polythene bags. However, from the late 1980’s onwards some organizations began to shift their attention from these ‘end of pipe’ approaches towards developing ‘clean’ manufacturing, which generates less pollution and waste in the first place and makes efficient use of energy and materials (Sangwan, 2006a).

Current practices of product development in manufacturing organizations are still predominately based on traditional cost/profit models, aiming to achieve high quality of a product at low cost and high profit. Environmental requirements are mainly considered as an unavoidable ‘must’, which generates additional design constraints and increases the costs. In an approach like this, environmental assessments are carried out fairly late in the product development process. They are not integrated with existing development activities, and are likely to increase the development costs. This paradigm of product development towards low cost and high profits is unlikely to change significantly as organizations have to make profits for their existence. However, the integration of environmental requirements through life-cycle stages of a product is a likely approach, leading to a new paradigm of environmentally conscious manufacturing (ECM).
Introduction

Environmentally conscious manufacturing (ECM) is concerned with developing methods for designing and manufacturing of new products from conceptual design to final delivery, and ultimately to the end-of-life disposal such that all the environmental standards and requirements are satisfied. In recent years, environmental awareness and recycling regulations have been putting pressure on many manufacturers and consumers to produce and dispose of products in an environmentally responsible manner (Sarkis, 1995). Almost every function within organizations has been influenced by external and internal pressures to become environmentally sound. Issues such as green consumerism and green product development have impacted marketing. Finance, information systems and technology, human resources and training, engineering and research, and development are all organizational functions that have been influenced by these environmental pressures. One of the functions that has been profoundly influenced by environmental pressures is the organizational operations and manufacturing function. The traditional reactive responses to these pressures are now being supplemented and replaced by more proactive, strategic, and competitive responses (Gungor and Gupta, 1999). Many businesses have begun to realize that there is some profitability to environmentally conscious business practices (Gungor and Gupta, 1999). Being an integrated approach, it will not purely add-on some constraints, but it will identify new environmental features of a product that have the potential to create additional market and profits (Kaebenick et al., 2003). Environmentally conscious manufacturing is also known by plethora of different names – clean manufacturing, green manufacturing, environmentally responsible manufacturing, and sustainable manufacturing. Irrespective of the name, the goal remains the same – designing and delivering products that minimize negative effects on the environment through their production, use, and disposal.

The single largest problem in implementing environmentally conscious manufacturing as a system is the lack of performance measures (Sangwan 2006a). At present, managers have difficulty in assessing the impact of green manufacturing because of the lack of appropriate performance measures (Azzone and Noci, 1998). Without such measures, it is difficult to justify green manufacturing as an alternative option. As a result judgments about green manufacturing become costs in ethical or
moral terms. The traditional performance measures such as return on investment, profit and cash flow are invalid for the measurement of ECM practices as they are based on outdated traditional cost management systems, lagging metrics, not related to corporate strategy, inflexible, contradict continuous improvement and do not necessarily reflect the organization’s core competency. Therefore, proper performance measures, derived from corporate strategies and capabilities, are a prerequisite for the implementation of advanced manufacturing systems like environmentally conscious manufacturing systems to survive in today’s competitive environment.

1.2 BACKGROUND

In recent years, performance measures have become paramount important as they are the pre-requisite for continuous improvement of any organization. They are mainly used to compare the performance of different organizations, plants, departments, teams and individuals, and to assess employees (Kennerley and Neely, 2003). For companies to ensure achievement of their goals and objectives; performance measures are used to evaluate, control and improve production processes. Many organizations have spent considerable time and resources implementing balanced performance measurement systems (Ghalayini and Noble, 1996). The literature in the field of performance measurement emphasizes the importance of maintaining relevant measures that continue to reflect the issues of importance to the business.

The performance measurement literature has had two main phases. The first phase began in the late 1880s and went through the 1980s. In this phase the emphasis was on financial measures such as profit, return on investment, return on sales and productivity. The second phase started in the late 1980s as a result of changes in the world market. Companies began to lose market share to overseas competitors who were able to provide higher quality products with lower costs and more variety. To regain a competitive edge, companies not only shifted their strategic priorities from low cost production to quality, flexibility, short lead time and dependable delivery, but also implemented new technologies and philosophies of production management such as computer integrated manufacturing (CIM), flexible manufacturing systems (FMS), just in time (JIT), total productive maintenance (TPM), total quality management (TQM) and Environmentally Conscious Manufacturing (ECM). The implementation of these changes revealed that traditional performance measures have
many limitations and the development of new performance measurement system is required for success (Ghalayini and Noble, 1996; Toni and Tonchia, 2001; Chenhall, 1996; Dangayach and Deshmukh, 2003; Davies and Kochhar, 2002; O’Mara, 1998; Skinner, 1986; Kaplan and Norton, 1992). The emerging performance measures should be related to manufacturing strategy; primarily non-financial measures i.e. operational so they can provide managers, supervisors and operators with information required for daily decision making; simple measures so that shop-floor operators can easily use and understand them; measures should foster improvement; and measures should change as is required by a dynamic market place (Kennerley and Neely, 2003; Ghalayini and Noble, 1996).

The literature related to the performance measures for environmentally conscious manufacturing is very limited. Azzone and Noci (1998) suggested a framework for operations managers wishing to design environmental performance measurement systems. They provided operational guidelines on performance measurement system architecture and the appropriate measurement techniques to provide support in devising performance indicators that best suit the intended “green” manufacturing strategy. Wee and Quazi (2005) established seven critical factors for environmental management – top management commitment, total involvement of employees, training, green product/process design, supplier management, measurement and information management. However, this paper has not included the costs and benefits of ECM which are essential for the survival of organizations in today’s competitive environment. Moreover, the middle management and logistics design have not been included in performance measures. The middle management often confines its attention to issues of quality and productivity. If it adversely affects this, they will be against it (Melnyk and Smith, 1996). Issues of packaging, transportation, and storage are essential from the life cycle concept and therefore the design of logistics becomes a pertinent issue in ECM. According to Wee and Quazi (2005) there is a need to focus on environmental issues for improving the performance of organizations. Sarkis (1998, 1999) evaluated the environmentally conscious manufacturing systems using multi-attribute decision models. In the first paper (Sarkis, 1998), he applied analytical network process (ANP) to evaluate alternative systems based on environmentally conscious business practices components - design for environment, life cycle analysis,
total quality environment management, green supply chain management and ISO 14000 EMS requirements. In the second paper (Sarkis, 1999), he combined ANP with DEA (Data Envelopment Analysis). Various decision factors taken are: quality, recyclability, costs, waste reduce, waste pack and compliance. However, decision making is not only strategic but also involves issues at the tactical and operational levels and this aspect was ignored by Sarkis in both the papers. Sangwan (2006b) identified performance measures for environmentally conscious production from literature but these performance measures have not been tested by empirical studies. Ries et al (1999) have pointed out the lack of environmental performance evaluation as one of the barriers for the successful integration of environmental aspects in product design.

The need of a comprehensive evaluation process from environmental perspective is also reflected in National Environment Policy, 2006 (NEP 2006) of India approved by the Union Cabinet on 18th May, 2006. NEP 2006 clearly mentions the drawback of existing system of evaluating the products based on various eco-labeling as it says “…at present, nonpublic bodies have established several labeling schemes in India’s export destinations, with no satisfactory evidence of being based on scientific knowledge, or participation by the potentially affected producers. Moreover, they may be based on prescriptions of production processes, and not only of the product characteristics, and for this reason, their mandatory application is inconsistent with provisions of the WTO regime.” Moreover, NEP 2006 is also skeptical of various Environmental Management Systems (EMS), such as ISO 14000 as their adoption may involve transaction costs, which, for small and medium enterprises may be significant in relation to their total investment.

Therefore, there is a strong need to develop performance measures for environmentally conscious manufacturing so that these systems can be evaluated and justified for either continuous improvement or implementation. The existing meager literature on ECM performance measure has mostly been conceptual in its origin and also has very limited theoretical basis. Second, the prior work in the area of performance measurement failed to capture the entire domain of environmentally conscious manufacturing. Third, the literature is based either on examinations of current best practices or the authors’ personal experiences, indicating the need for
development and validation of performance measures and their variables which take into account all the aspects of environmentally conscious manufacturing.

1.3 SCOPE AND OBJECTIVES
The aim of present study is to develop and validate a comprehensive set of performance measures and their items/variables for environmentally conscious manufacturing. The objectives of this study are:

- To study the manufacturing performance measures currently in use and to explore their applicability for environmentally conscious manufacturing.
- To develop performance measures and their variables/items for environmentally conscious manufacturing.
- To assess reliability and validity of the proposed performance measures by empirical study.

1.4 METHODOLOGY
The objectives defined in the preceding section are achieved through the accomplishment of the following tasks:

- A thorough review of literature related to manufacturing performance measures.
- Development of a theoretical framework for performance measurement based on the in-depth review of literature.
- Development and testing of a survey instrument.
- Data collection.
- Reliability assessment and validity analysis of performance measures by statistical tools.

1.5 ORGANIZATION OF THE THESIS
Chapter 1 presents the importance of environmentally conscious manufacturing and performance measurement, background of the research work, scope and objectives of the study, and methodology adopted for the proposed research work. Chapter 2 presents, a review of traditional performance measures and non-traditional
performance measures along with their limitations. A review of some popular conceptual frameworks of performance measurement is also presented. Chapter 3 discusses the process of deriving the performance measures of environmentally conscious manufacturing. This chapter also presents an exhaustive literature review to identify the performance measures and variables/items representing the measures of environmentally conscious manufacturing. Chapter 4 presents, the questionnaire design. Chapter 5 presents descriptive and importance index analyses of collected data used for the study. Chapter 6 presents, reliability and validity assessment for the validation of performance measures by using the SPSS for Windows® statistical tool. Finally, chapter 7 gives the conclusions of the research work with limitations and scope for future work.