CHAPTER 2

LITERATURE REVIEW

2.1 INTRODUCTION

Elaborate reviews of specific studies on manufacturing, analysis, measurement, optimization and productivity improvement along with a range of research methodologies adopted for developing a successful strategy for productivity engineering are presented in this chapter. The reviewed productivity improvement methodologies are classified and described in the subsequent subsections.

2.2 ANALYSIS

The manufacturing productivity concept can be discussed in many ways but the most accepted concept available in the literature is labour productivity, Partial productivity and total factor productivity. Partial productivity relates to the multiple inputs to net outputs. Whereas, total factor productivity (TFP) expresses the ratio of the outputs produced to all resources used. The skill of the workforce is a dominant input of a manufacturing system. Caves et al. (1982) observed that efficiency of transformation of inputs to outputs is largely dependent on the skill of the workforce. Skill is one of the main inputs of a production process. Recent publications by Scott and Pisa (1998) recognize and analyze the need for a coherent, systematic methodology for productivity measurement and analysis at the factory level. Due to advances in manufacturing technology, manufacturing system and
process are becoming complex and are increasingly characterized by high level of automation, integration and greater demands on performance.

Labor productivity is determined by that person’s potential to reach the highest level of his possible performance (Singh et al., 2000). Indeed, labor productivity mainly measures the performance of labour. Haskel and Hawkes (2003) found that higher qualifications support innovation and a more sophisticated production process and these are known to be a leading cause of higher productivity. It is evident that the highly-productive manufacturing organizations tend to have a highly educated and skilled workforce more so than the least productive (Tangen, 2005). Furthermore, degree of skill is recognized as an effective driving force for enhancing manufacturing performance (Shahidul and Anwar 2007). Metrics for measuring and analyzing the productivity of manufacturing operations from the equipment level to the system level are of increasing importance to companies seeking to continuously optimize existing operations.

2.3 PRODUCTIVITY MEASUREMENT

Goldratt and Cox (1986) and Goldratt and Fox (1986) mentioned that the goal of a factory is to make money. McLaughlin and Coffey, 1990 observed that the complexity of input and output measures impose serious constraints on productivity measurement. There are three important measures which are defined in monetary rather than physical units: throughput, inventory and operational expenses. The first should be maximized and the last two should be minimized. Gummesson (1992) suggested the need to identify in measuring productivity before making any attempt to measure it, otherwise productivity measurement is more complex.
Productivity measures the capability to meet the demand and not the sales. Consequently, attempts to measure the output in terms of units sold in a shop, mixes both a production measure and a demand measure in a way that makes it difficult to quantify. Even if the traditional measures of productivity are considered, one question that still remains unanswered is: what should be measured as input and output respectively? From the viewpoint of measurement theory, the representative of a chosen measure becomes a crucial issue. From the viewpoint of reliability, the problems of measurement may be stated as follows (Vuorinen et al., 1998).

- How can the quantity of inputs and outputs be measured?
- How can the quality of inputs and outputs be measured?
- How can the interrelationship of different output and input factors be operationalised?

Mclaughlin and Coffey (1990) observed that complexity of input and output measures impose serious constraints on productivity measurement. Slack (2001) mentioned five types of performance objectives based on cost, flexibility, speed, dependability and quality. Tangen (2002) mentioned that performance measurement criteria must be driven by strategic objectives and the measures must provide timely feedback. Performance measurement is defined as the process of quantifying the efficiency and effectiveness of action (Tangen, 2003).

2.4 OPTIMIZATION

Productivity improvement and enhancement of labor quality can be achieved by the enhancement of technical efficiency (Sengupta, 1988)
Productivity growth would rise by the use of the latest available technology. The rate of production in the hi-tech industries is normally greater than the conventional modes of production (Qazi and Yulin, 2012). Productivity improvement leads the economy of an industry or firm to achieve better than before with the unchanged inputs in the production process. Total factor productivity is generally defined as a ratio of a measure of output to a measure of input. DEA (Data Envelop Analysis) is a linear programming tool available to DMU (Decision Making Units) to evaluate performance based on the multiple outputs and inputs and the methodology (Tanese et al., 2012). In order to calculate productivity, we have to solve different linear programming problems. The efficiency change requires calculation of additional linear programming (Fare et al., 1994).

In particular, scholars are interested on what are the sources of output growth, whether they are input-driven or due to increase in productivity. To date, several attempts have been made to estimate total factor productivity (TFP) in the manufacturing sector (Timmer, 1999).

The decline in manufacturing export partly was due to competitions from other lower-wage countries as well as decline in competitiveness because of limited export products and markets (Dhanani, 2000). Problems were further intensified by standstill in micro-economic reforms as politically powerful business groups and state intervention re-emerged in various sectors. At the same time, widespread corruptions and rapidly mounting short-term external debt were also threatening macroeconomic stability (Aswicahyono and Hill, 2002).

All these studies identified two sources of growth: input growth and a residual measure, which interprets to firms not being fully efficient, and hence improvements in the technical efficiency might lead to growth (Mahadevan, 2003).
2.5 PRODUCTIVITY IMPROVEMENT

A survey by Ford et al. (1987) indicated that linear programming, simulating and network models are among the most highly used methods.

During the last two decades, attempts have been made to develop system-based techniques for manufacturing system analysis and design for productivity improvement. More specifically, several researchers (Greene, 1991) have argued that quality and productivity cannot be dealt with separately. Morgan’s (1989) review provided evidence on PERT/CPM, linear programming and simulation as being among the most frequently used methods.

Grunberg (2003) mentioned that the improvement of manufacturing productivity have been on since the start of the industrial era as per the first known and well-documented practitioners in the area of performance improvement. Competition between companies has increased as markets have become increasingly global and there are no signs that this competition will ease. This increased competition creates an even greater need for better improvement methods that can sustain competitiveness.

OR is a discipline based on applied mathematics for quantitative system analysis, optimization and decision-making (Leon, 2004). The OR approach emphasizes mathematical modeling leading to the deepest understanding of the behaviour of systems.

There are a number of OR-based methods that have been developed in the past to model a manufacturing system for productivity improvement.
Manufacturing system productivity measurement and improvement can be done using rigorous mathematical modeling, operations research (OR) based methods, control-theoretical methods driven by information systems, system analysis-based methods for productivity improvement and continuous productivity improvement methods. A survey of performance metrics-based methods and the motivation for a factory-level approach for productivity measurement and improvement comprises a survey of commercial tools available to measure manufacturing system performance (Muthiah, 2006).

2.6 CONCLUSION

Productivity engineering is gaining momentum due to the practical ways developed by the academic community and organizations for retaining the competitive position in the worldwide market. Export-oriented units are in need of developing efficient and effective manufacturing processes due to the increasing complexity and magnitude of their business operations. There is only a restricted body of research in productivity engineering specifically in the area of productivity improvement. A comprehensive survey of the development of such diverse techniques are mentioned in this chapter.

A common mistake is to equate productivity with production – the amount of a product or service produced (Stainer, 1997). This is not necessarily true. Productivity is a relative concept. Moreover, improvement in productivity can basically be caused by the following five different relationships:

1. Output increases faster than input (managed growth);
2. More output from the same input (working smarter);
3. More output with a reduced input (the ideal);
iv. Same output with fewer inputs (greater efficiency); and

v. Output decreases, but input decreases more (managed decline).

It is evident that many of the complexities involved in reality for manufacturing processes, in general, are identification and elimination of wastages and scraps as well as the implementation of new processes. It is observed from the literature that the solution approaches are to be developed to optimize productivity. Motivated by such observations and findings, the current research is aimed at developing efficient analysis and optimization of manufacturing processes to yield a better productivity.