CHAPTER 1
INTRODUCTION

In this chapter, the motivation, objectives, approaches and methodologies, scope and limitations of this research work are discussed. The organization of the thesis is listed at the end of this chapter.

1.1 MOTIVATION OF THE RESEARCH WORK

Modern industrialization demands high quality product at the lowest cost which requires an understanding of the complex relation among many factors of manufacturing such as product design, selection of materials and manufacturing process, planning and utilization of manpower and equipments. Most of the formal techniques that have been used for decision-making are the selection of the best alternative with respect to a certain figure of merit. Such single criteria decision making will not be sufficient because of the fact that manufacturing is a very complex system comprising a large number of complex and interdependent subsystems. Many researches had been done with the single objective of reducing the throughput time or reducing the cost. Only a limited amount of work has been done to understand the problems of managing the totality of the manufacturing system and to identify the degree and nature of the interrelationship of the systems. But today’s manufacturing involves technological, economic, ethical, political, legal, and social factors that affect an organization. So, the present manufacturing system / process requires Multi-Criteria Decision-Making (MCDM) approach. MCDM refers to making decisions in the presence of multiple, usually conflicting criteria in complex and unstructured situations. Such lagging emphasizes to solve many
multi-attributes problems in manufacturing by using a MCDM approach called digraph and matrix approach.

1.2 OBJECTIVES OF THE RESEARCH WORK

The main objective of the research work is to solve various unstructured, unsolved problems using graph theory and matrix approach which is an integrated MCDM approach in which all contributing attributes are considered simultaneously. The main objective is to include the analysis and evaluation of manufacturing systems and processes in order to select the best one from different alternatives. To simplify the calculation, software has been developed. The main objective of the thesis is listed below:

- To identify various real industrial unsolved problems in manufacturing systems/processes involving multi-attributes.
- To analyze the nature of the problem i.e., identifying the factors affecting the determined problems through literatures and management techniques.
- To identify the relative importance between the factors.
- To apply graph theory and matrix approach to the identified problems and finding the solution.
- To develop the software in order to simplify the manual calculations.
- To confirm the solution by solving the same problem(s) using other methods.

According to the objectives of the research work, a jig is evaluated taking into account all attributes like location, clamping, loading and unloading, etc. Another case study is carried out for the selection of the best motor bike kicker from two different models. Milling machine selection problem is considered for the comparison of AHP and ANP with graph theory and matrix approach.
1.3 APPROACHES AND METHODOLOGIES

In this research work, a detailed methodology has been described for the digraph and matrix approach. This systematic approach includes the following steps:

a. Identifying the contributing attributes for the problem considered.

b. Construction of a digraph model by considering all the attributes and their relative importance.

c. Development of matrix from the constructed digraph model.

d. Deriving the permanent function, a multinomial function.

e. Obtaining an index (a numerical value) by substituting the values for the variables in the permanent function. The index is nothing but an indicator of the performance of the system/process.

f. Arranging the indices for different alternatives in ascending order and selecting the best one whose index value is higher.

In this research work, three case studies have been analyzed by using this methodology. A permanent function solver is developed using MATLAB for calculating the selection index/evaluation index.

1.4 SCOPE OF THE RESEARCH WORK

In general, most of the systems or processes consist of many subsystems or components or factors which are interdependent on each other and they influence the performance of the system/process. The problems in a system/process consist of many attributes that cannot be solved by a simple tool. For example, activity based costing method considers the cost of the different activities and omits all other contributing factors. Even though many tools like ANN, AHP, ANP, DOE, GA, and fuzzy logic are found in application, new approaches and tools are required to solve some complex problems. Since all these tools have different features and characters, one tool may be suitable for a problem where as another tool may not be suitable.
Because of the simplicity and rationalization, digraph and matrix approaches are found to be suitable to solve many unstructured and unsolved problems in manufacturing.

1.5 LIMITATIONS OF THE RESEARCH WORK

In certain problems, some attributes and their relative importance may not have quantitative values but qualitative values. In such cases, the qualitative values are to be normalized to some scale, for example say 0 to 10 scales. Assignment of value is based on assumptions which require more experience in the field related to the problem. The normalization process also requires much effort to conduct brain storming session, survey and group discussion. It is necessary to refer many literatures and handbooks to get statistical data. Some times a questionnaire has to be designed to arrive at the numerical value for certain attribute which is cumbersome and time consuming one.

1.6 ORGANIZATION OF THE THESIS

Chapter 1 This chapter briefs the motivation, objective, approaches and methodology, scope and limitations of this research work.

Chapter 2 This chapter presents the literature review on various tools applied to solve different kinds of problems in manufacturing systems and processes. It also provides the limitations of the various tools applied in the existing researches and the need for this research work.

Chapter 3 This chapter depicts the basics of the manufacturing systems and processes. Classifications and characteristics of the systems and processes are also described in this section.
Chapter 4  This chapter discusses various multi-attribute decision making tools. It briefs the methodology applied in those tools and also lists the strengths and weaknesses of those tools.

Chapter 5  This chapter portrays fundamental concepts of the graph theory. Various types of graphs, digraph, adjacency matrix and insistent matrix are explained in this section.

Chapter 6  Step by step procedure of digraph and matrix approach is explained in this chapter with necessary illustrations. A permanent function solver is developed using MATLAB for calculating the selection index/evaluation index.

Chapter 7  This chapter illustrates two case studies which are carried out by using the digraph and matrix approach. The first case study deals with the problem on evaluation of jig for flange coupling. The second case study deals with the selection of a motor bike kicker from different alternatives.

Chapter 8  This chapter exemplifies evaluation of digraph and matrix approach through comparison. Two methods namely Analytical Hierarchical Process (AHP) and Analytical networking process (ANP) are considered for the comparison. The problem of selecting a milling machine from different alternatives is considered for the comparison. The results from three methods are discussed in this chapter.

Chapter 9  This chapter displays the summary of this research work. This includes conclusion, major contributions and future scope of this research work.