CHAPTER 8
RESULTS AND DISCUSSION

Since the early 1980s, when the Six Sigma approach was first introduced and adopted by Motorola and later successfully tested by GE Corp. in 1990, the method has become the most prominent administrating technique for quality improvement. Having arisen in large corporations, Six Sigma is surely one of the most comprehensive approaches for company development and performance improvement of products and processes. Nevertheless, it appears that the majority of small and medium sized enterprises (SMEs) either does not know the six sigma approach, or find its organization not suitable to meet their specific requirements. In the SME environment, there is little spare resource; every employee has a key role and usually several. The challenges of smaller companies are funding and logistics, a limited talent pool, multi-hat roles, and less exposure to management innovations in other industries. However the other side of the coin is that it is easier to implement TQM in SMEs because the power of decision making does not depend on extensive hierarchies but lies with the owner managers.

For many large corporations like General Electric, Six Sigma has become the centre of nearly every business activity, and a very important step to ensure long-term competitiveness. In today’s highly competitive environment, it is also becoming increasingly important for SMEs. Furthermore, the success of large corporations’ quality programs is critically dependent on the supply of high quality goods and services from suppliers, which are most likely to be SMEs.
Consequently, the competitiveness of SMEs affects the competitive position of an economy as a whole. In today’s crowded markets, firms cannot afford to stand still, waste resources by adopting a trial-and-error approach to formulating a strategic direction, and deliver poor quality products or services.

Therefore a general Six Sigma concept for SMEs needs to be adjusted to their core requirements. Which represents a major difference to Six Sigma programmes in large corporations.

Keeping in mind above points a modified Six Sigma cycle has been demonstrated in this work which suits the small industries especially plastic injection molding enterprises. The modified cycle called DAURR (Diagnose, Analyze, Upgrade, Regulate and Review) has been designed according to need of small and medium injection moulding enterprises. The above proposed cycle can be used in small and medium plastic injection moulding firms having limited talent pool and funding. The management tools and statistical methods used in each phase of the cycle have been demonstrated with the help of a case study. The feasibility of modified cycle was also proved with the help of a case study. The method has been employed for the improvement in two major quality characteristics (hardness and over shrinkage) of injection-moulded nylon-6 kamani bush produced in a small enterprise.

Prior to application of the Six Sigma approach, compromise among various interacting process parameters were difficult for obtaining the desired quality characteristics. After the implementation of the proposed method, targets for improvement were clearly defined with the problems and causes being identified. The process parameters were then optimized for quality characteristics improvement so that the Six Sigma standard was reached.
This approach not only significantly improved quality characteristics of the bush but also achieved the targets of further improvement in review phase. Furthermore, the Taguchi method adopted in the analysis step successfully identified the optimal combinations of process parameters within the experimental window, as well as the most significant factors affecting the quality characteristics. In the meantime, the factors are evaluated via ANOVA of S/N ratio for various combinations of process parameters throughout the experiments.

Further the second order regression model was prepared separately for both the characteristics. These second order regression models were further validated with the help of neural network models which had been prepared separately for both hardness and bulging prediction.

The most important part of this work was that the prediction of both quality characteristics (over shrinkage and hardness) were made with the help of regression model as well as neural network model, by varying the process parameters already optimized by Taguchi method. This helped in enhancing prediction capability as well as selection of more optimized process parameter levels. A comparison of prediction capability of both the models was also shown in work, which proved that neural network model has slightly better prediction capability.

Simultaneous use of both the models (ANN and Regression model) for prediction, of the quality characteristics at different values of process parameters, is very much convenient in selection of optimum parameter levels.

In present work, the upper process capability index CPU for hardness of nylon-6 bush has improved from 0.56 to 1.16, process mean increased from 69.79 to
83.44, while the lower process capability index CPL, for over shrinkage of nylon-6 bush has improved from 0.24 to 1.225, process mean decreased from 0.1015 to 0.0615. The process has improved from 3.19σ standard to 4.99σ standard for hardness while it improved from 2.38σ standard to 5.18σ standard for over shrinkage.

This work shows that process was improved closer to Six Sigma standard by changing the processing conditions only without any change in the part design, mould design, and machine performance. To further take the process up to Six Sigma standard, in future, we can apply the proposed approach for, mould design as mentioned in review phase of the work.

The present work offers advantage in choosing the best tools that fit the SMEs as well as it can be used for achieving six sigma standard in plastic injection moulding companies having limited resources and expertise.

This work also demonstrates a process for finding the best compromises between several performance measures for one case of IM. Through finding the efficient compromises between performance measures, one can trace back the corresponding levels of the controllable variables.